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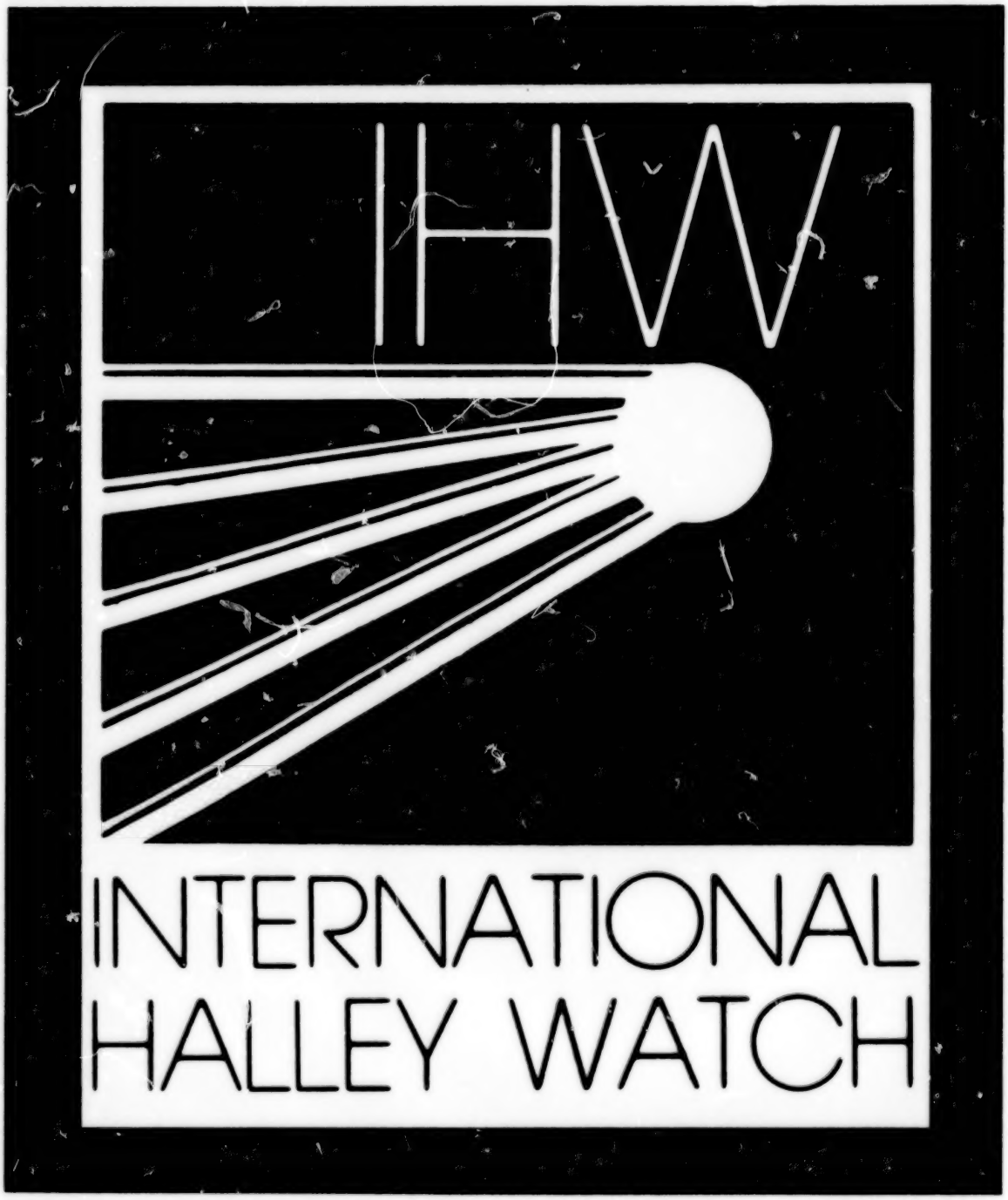

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THE INTERNATIONAL HALLEY WATCH NEWSLETTER

Issue No. 6 January 1, 1985

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Editorial

This is the sixth IHW Newsletter. Future issues will appear on an irregular or bi-yearly basis. Our hope is to maintain open lines of communication between the IHW Lead Center, discipline specialists, observers, flight projects, and other interested readers. We invite short contributions on scientific, instrumental, or social aspects of preparations for the Halley apparition. Please submit items of interest to the editor at the address below.

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LETTER

Sir:

I'm somewhat surprised about the remarks in regard to the observations of Comet Halley in 1531 in IHW Newsletter No. 5, p. 24.

The discovery that the tail of Comet Halley pointed in the direction away from the Sun was already published by P. Apianus in his "Practica auff duz 1532 jar" (Landshut 1531), nine years before his Astronomicum Caesareum. Also in the book describing the Comet of 1532 (the title page of which is printed on p. 25 in Newsletter No. 5), this discovery had been noted and demonstrated by observations of that comet. (This book was finished by Apian 1532 Dec. 14.) Thus, there is no doubt about Apian as the discoverer of this fact and not Fracastoro in Homocentrica (1538).

The first general remark about the direction of cometary tails was made by observers in China in connection with the apparition of Comet Halley in 837 (see Biot, 1846, p. 79). However, most short Chinese reports are similarly general, like "on the evening a comet appeared in west and the tail pointed to east" and vice versa. I think that this shows that there was not any connection concluded between the position of Sun and the tail direction.

The second figure in Newsletter No. 5, p. 25, is extracted from Theatrum Cometicum by S. Lubienietsky (Amsterdam 1668).

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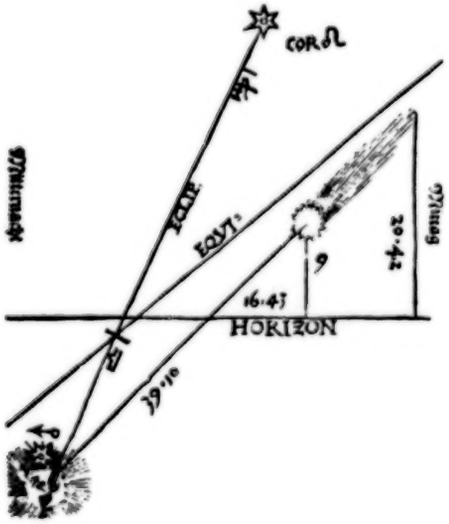
Biot, J.-B., 1846, Conn. d. T.



Figures. Drawings from Apian's report on the comet of 1532.

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A GIACOBINI-ZINNER WATCH (GZW)

R. L. Newburn, Jr. and J. Rahe
International Halley Watch

As most readers of this Newsletter are aware, in 1982 Dr. Robert Farquhar of GSFC discovered a complex trajectory that could take the ISEE-3 spacecraft from its existing halo orbit about the L1 (Lagrangian) point in the Earth-Sun system to an encounter with P/Giacobini-Zinner (G-Z) on September 11, 1985. NASA and the investigators agreed to this diversion, and the complex manuevers were begun that resulted in escape from the Earth-Moon system on Dec. 22, 1983. Renamed International Cometary Explorer (ICE) at that time, the spacecraft is now well on its way to G-Z encounter.

The ICE project soon arrived at the same conclusion as the Halley projects, namely that they had a critical need for ground-based data of many types. The ICE project has supported astrometric studies required to get the spacecraft to G-Z. They have asked that a G-Z Watch (GZW) be created as a low cost adjunct to the IHW, making use of existing IHW facilities and personnel wherever possible, to support the ICE project. Your IHW Leaders have agreed to do so.

The scientific objectives of the GZW are to provide a coordinated scientific study of P/Giacobini-Zinner during its 1985 apparition and to supply the larger scale physical and temporal scientific context into which detailed particle and field data taken by ICE on September 11, 1985 will be fitted. The scientific study will be of great value for comparison with Halley, providing data taken in the same way with the same instruments, processed in the same way, and archived in the same way. Since ICE will fly blind into G-Z, having no imaging or other remote sensing instruments, the G-Z Watch is a necessity for understanding the environment into which the spacecraft will fly and the scientific context in which its measurements must be interpreted.

A proposal was sent to NASA for some additional funds to cover manpower at the DS Centers and Western Hemisphere Lead Center to physically process the data. These funds have been approved. Administratively the G-Z activities will be carried out as a part of the IHW, the only distinction in personnel being designation of a software person at each DS center whose first responsibility will be G-Z data. Eventually a G-Z volume will be included in the "Halley" archive.

Significant observing of G-Z should begin about February 1, 1985 as the comet separates from the Sun (elongation will be 53° on that date). It will then be 2.7 AU from the Sun and near the celestial equator. Emphasis should be placed upon astrometric positions, photometry, and spectroscopy for some months, the latter two building up a picture of gas and dust production and gas composition as a function of heliocentric distance. Infrared observations of the dust should be possible at least by June as the comet reaches 1.5 AU from the Sun. The meteors associated with G-Z are so unusual (apparently low density, fluffy things) that a study of the G-Z dust size distribution and thermal properties is extremely important.

Special G-Z days are hereby established for four days around the time of encounter (Sept. 11), with enhanced observing from about Sept. 1 through Sept. 20. Unfortunately the comet is very close to the Moon at the time of encounter (5° on Sept. 9 and 29° on Sept. 11, increasing to 55° on Sept. 13), although

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mercifully the Moon will be only 12% illuminated on Sept. 11 (30% on Sept. 9 and 2% on Sept. 13). Clearly better quality physical observations will be obtained after encounter, as the Moon approaches new and moves eastward away from the comet. On the day of encounter there will be only a short time when the comet is above the horizon before the Moon rises.

Large Scale Phenomena sequences and Near Nucleus studies using various imaging techniques should be undertaken when G-Z is near both Earth and Sun, as it is around the time of encounter. The former will supply visual knowledge of the large scale structure of the tail as a function of time, while the latter will provide the best knowledge of the actual region into which the spacecraft flies. Radio studies may provide information on cometary activity at some times when it is otherwise difficult to observe. The relatively close approach to Earth (.47 AU) will help all the nets.

Everyone should realize that work on G-Z will be a good tune-up for Halley. Halley will still be 2.6 AU from the Sun at the time of G-Z encounter and much less active than G-Z throughout September. G-Z will provide an opportunity to do good science and to recognize any last instrumental problems before the Halley push. We hope the Halley spirit and enthusiasm, then still building, will carry over to G-Z in this fashion. Halley will always take first priority because of prior international commitments and the large body of international personnel involved whose chief interest is Halley, but we hope the good science to be done and the obvious synergism of Halley and G-Z together will induce everyone to do his best for the GZW as well as the IHW.

THE SPARTAN HALLEY MISSION

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Abstract

Shortly before Comet Halley reaches perihelion on 9 February 1986 a University of Colorado ultraviolet spectrometer experiment will make unique measurements of the coma and tail. The experiment will be transported into space by the Shuttle Orbiter Challenger in late January 1986. Two ultraviolet spectrometers and associated instrumentation will be aboard a Spartan carrier that will be deployed to function as an autonomous subsatellite for about 48 hours. The ultraviolet spectrum of the coma and tail will be measured in the wavelength range 1250 to 3200 Å at a resolution of 2 Å.

Introduction and Scientific Background

The Spartan Halley Mission (SHM) ultraviolet observations will determine the composition of the coma and tail near the time of perihelion when Comet Halley is 0.59 AU from the Sun. At this time, the angle between the comet and the Sun is small as seen from Earth, varying between 10° and 22°. As shown in

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Figure 1, Earth's relative position to the comet's path will place the comet almost directly behind the Sun at the time of its perihelion as seen from Earth.

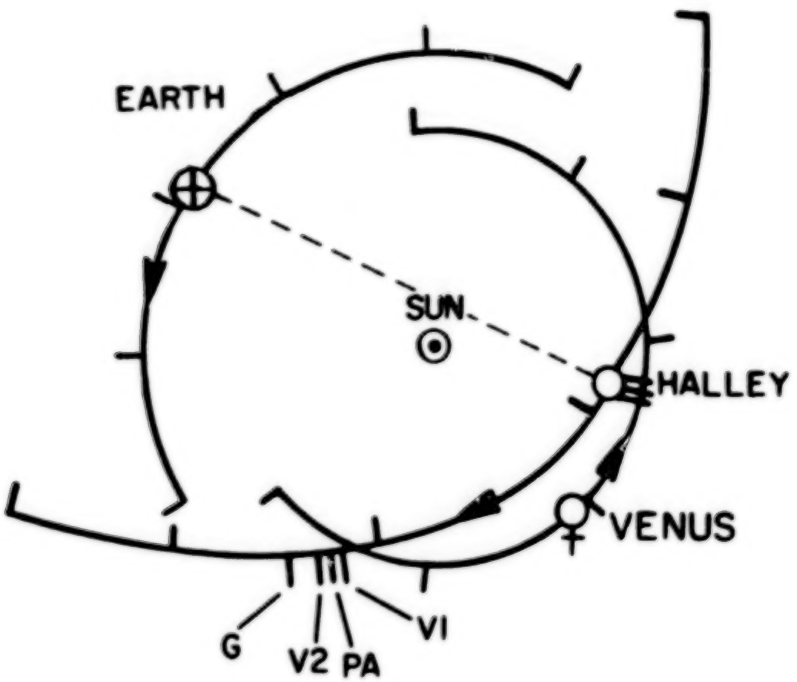

Figure 1. Viewing geometry of Comet Halley for several planned space experiments. The SHM ultraviolet spectrometers in orbit around Earth will observe the comet during the last week in January 1986 just before its perihelion passage on 9 February 1986. The Pioneer Venus spacecraft, currently orbiting Venus, will observe the comet from the end of January until mid-March 1986. The Russian spacecraft, Vega 1 and 2 (V1, V2), the Japanese Planet A (PA), and the European Giotto (G) will make their observations in March 1986.

Perihelion is the time of the maximum rate of evaporation of ices from the cometary nucleus. Figure 2 shows that comet activity will be increasing at the time of SHM observations. The period of increasing activity is the ideal time to measure the sublimation of atoms, molecules, and ions from the comet nucleus. As the comet nears the Sun, the temperature should rise, releasing ices and clathrates trapped in a lattice in the nucleus. As the temperature rises, the rate of evaporation of the ices increases, and the composition of the evaporating gases may change. The opportunity for the greatest variety of material to evaporate is near perihelion when the temperature of the nucleus is greatest.

One of the highest priority objectives of the SHM will be to measure the production rates of atomic oxygen and hydroxyl. The production rate of water, which is thought to be the dominant volatile in Comet Halley's nucleus, will be determined from these simultaneous observations.

The ultraviolet spectrum of Comet Halley near the time of perihelion passage in February 1986 will be observed between 1250 and 3200 Å at a resolution of 2 Å. The scientific objectives of the mission are to determine the amount of hydroxyl radicals (OH, 2810 and 3090 Å) and atomic oxygen (OI, 1304 Å) in the coma and to relate the production of these species to the photodissociation of water. In addition, we will search for nitrogen-containing molecules, such

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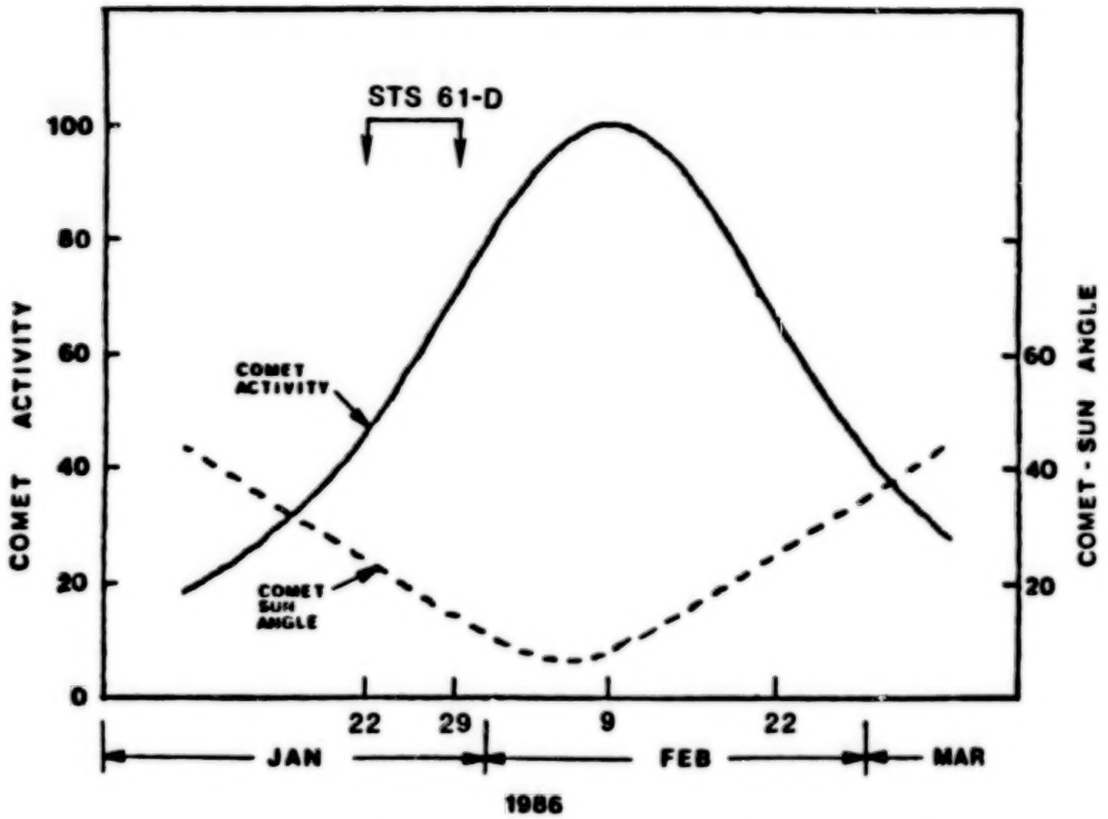

Figure 2. Launch period for SHM. The University of Colorado experiment is scheduled on Shuttle flight STS 61-D, to be launched during the period 22-29 January 1986. To show how comet activity is expected to vary near perihelion, the solid curve is plotted as $1/r^4$ where r is perihelion distance. The dashed curve shows the angle between the comet and the Sun as seen from Earth orbit. During the expected observation period, this angle is approximately 20°.

as NO (2150 Å) and CN^+ (2181 Å), for carbon atoms and carbon-containing molecules such as CI (1561 Å, 1657 Å), CO (2160 Å), CO^+ (2190 Å), CO_2^+ (2890 Å), and for sulfur atoms and sulfur-containing molecules such as SI (1820 Å), CS (2575 Å), and perhaps S_2 (2830 Å). Changes in the spectrum will be monitored during a 48 hour period preceding perihelion passage.

In addition to providing direct information on the water, nitrogen, and carbon chemistry in the coma and ion tail of Comet Halley, the species to be observed by SHM exhibit a variety of photoionization time constants and molecular weights that will, in turn, allow us to probe the comet on a number of different timescales and scale lengths. A review of rocket and satellite observations of comets is given in Feldman (1983).

The scientific importance of ultraviolet measurements of comets lies in the ability to measure the composition and rate of evolution of gases from the nucleus. Although some "parent" molecules are not directly detectable in the ultraviolet, they are broken down by sunlight into "daughter" radicals and atoms, and because all the important atoms (H, O, C, N, S) are UV-detectable, the atomic composition of the cometary gases can be measured. In addition to the atoms, many daughter radicals (e.g., OH, CO, CS) and ions (CO_2^+, CO^+) are readily observed. If the entire coma is mapped, then the total rate of emission of photons from a particular gas in the coma is readily obtained; then, knowing

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the lifetime of atoms or molecules of this gas and and the rate at which they emit photons, the total production rate of this gas follows immediately. Measurements, calculations, and estimates of these two quantities -- the lifetime and photon emission rate -- appear in the extensive literature on cometary research (see e.g., Feldman, 1983, and references therein). If the surface brightness of a part of the coma is measured, then the interpretation is more model-dependent; again, models meeting this interpretative requirement exist in the literature. The SHM observations of Comet Halley fall into both categories, because the angular size of the optical coma depends on the gas whose emissions are being observed. For example, the OH coma is very compact because of the short lifetimes of both OH and its parent H_2O; SHM will measure its complete photon emission rate. The atomic oxygen coma, on the other hand, is larger than the field-of-view, and SHM will measure surface brightness traces across it. Current and new models will be used to interpret these traces.

Instrumentation

The Spartan program is based upon the flight of sounding rocket class instruments aboard a Shuttle-deployed and retrieved platform. Currently planned Spartans provide a cold gas (argon) Attitude Control System (ACS) with gyros and Sun and/or stellar reference sensors as required. Spartans operate autonomously once in independent orbit and carry no transmitters or receivers for communications with either the ground or the Orbiter; for this reason they are designed with considerable internal automation, including preprogrammed attitude and science mode control instructions designed to accommodate a 48-hour mission at any time during an extended launch window. Spartans are battery powered, and all flight data are stored aboard a spacecraft recorder for playback after landing.

The Spartan Halley spacecraft is shown in Figure 3. The SHM will use the 200 Series Spartan carrier. Two co-aligned ultraviolet spectrometers (Figure 4) will be used for the observations of Comet Halley. They will be mounted on a stiff optical bench that can be accurately referenced to the Spartan ACS sensors and actuators. These spectrometers are derived from the ultraviolet spectrometers used on the Mariner 6, 7, and 9 missions to Mars (Barth et al., 1971). The spectrometer uses an Ebert-Fastie optical system with a 250 mm focal length. The UV gratings produce a dispersion of 15 Å/mm on the focal plane. The detectors are microchannel plate detectors with coded anode readouts (CODACON). The detector on the shorter wavelength instrument (1250-1660 Å) uses a cesium iodide photocathode; on the other instrument (1600-3200 Å), a cesium telluride photocathode. The detectors have 1024 anodes with a spacing of 0.4 Å covering simultaneously a wavelength range of 400 nm. With narrow slits, the effective resolution is 2 Å. These spectrometers and detectors have flown on rockets and successfully operated in space (McClintock, et al., 1982). A summary of the characteristics of the spectrometers is given in the Table.

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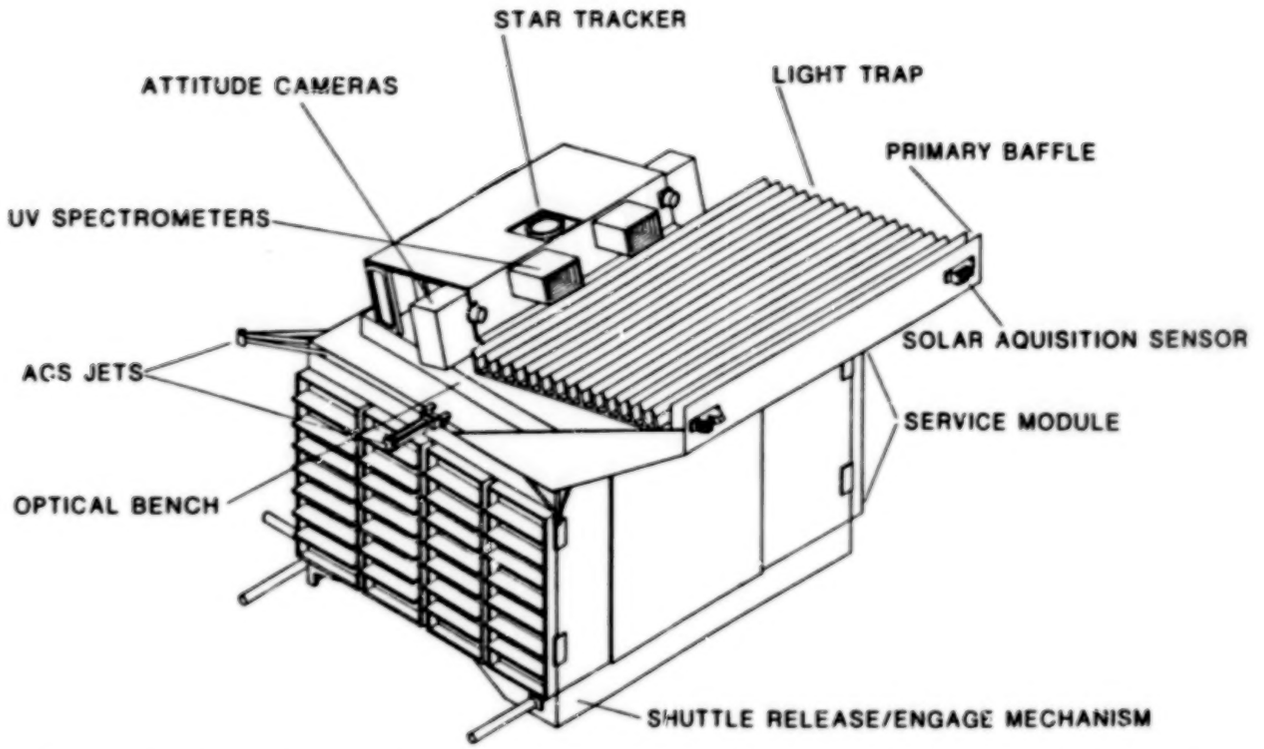

Figure 3. The Spartan Halley spacecraft. The experiment, consisting of two spectrometers, attitude cameras, startracker, suntracker, microprocessor, associated electronics, and elaborate baffling system, will be mounted on the optical bench attached to the service module.

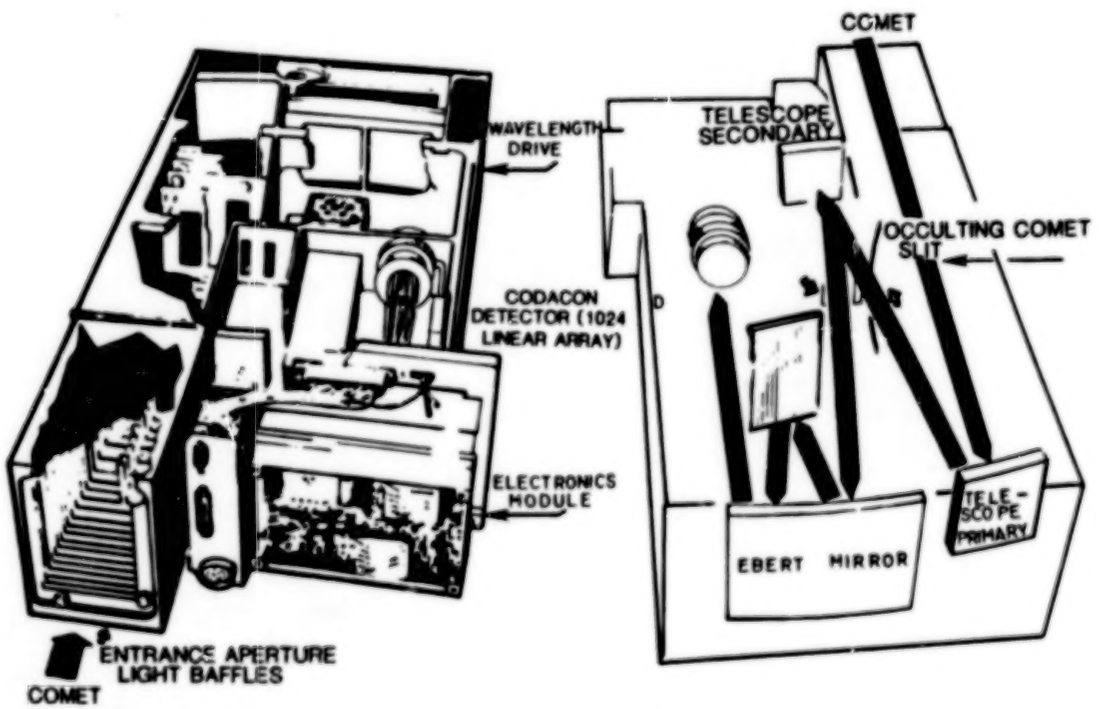

Figure 4. Ultraviolet Spectrometer. The SHM will carry two co-aligned spectrometers: one operating in the 1250-1660 Å wavelength region, the other, 1600-3200 Å. These instruments use an Ebert-Fastie optical system with a 250 mm focal length and photon-counting microchannel plate CODACON detectors. The 50 cm telescope has an elaborate set of light baffles.

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SPARTAN HALLEY SPECTROMETERS

Two Spectrometers

Ebert-Fastie Optical Design -- 250 mm Focal Length

Off-Axis Telescope -- 50 mm Diameter

Multichannel Detectors -- CODACON Design
1 x 1024 Channels -- 25 μm Spacing
CsI Photocathode -- 1250-1660 Å
CsTe Photocathode -- 1600-3200 Å

Spatial Resolution -- 1 x 80 arcmin

Spectral Resolution
CsI 0.40 Å/anode
6.0 Å resolution
400 Å coverage

CsTe 0.40 Å/anode
2.0 Å resolution
400 Å coverage/step

Grating Drives -- Microprocessor-Controlled

One factor in the choice of the Mariner-derived spectrometers was their inherent internal stray light rejection capability of 10^6 at 3° off-axis. This capability was originally provided to make possible observations of the high Martian atmosphere immediately adjacent to the bright planetary limb. The expected spatial resolution of the 1x80 arcmin slits will be 6.0×10^4 km during early 1986. Figure 5 illustrates the observational geometry for the instrument slits when viewing Comet Halley. The telescopes (see Figure 4) have elaborate baffling of the type used on the Mariner Mars missions in order to reject the intense sunlight at a comet-Sun angle of 10° (Pearce et al., 1971). In addition, a sun shade will baffle the telescope from direct sunlight. The sun shade is shown in Figure 3. Two knife-edge baffles located 30 inches from the entrance to the telescope baffles will shadow the instrumentation from direct sunlight. Twenty additional baffles in the light trap will minimize any interference from Earthshine on the Spartan Halley telescopes.

Additionally, two space-qualified Nikon F3 cameras will be used to reconstruct a precise history of the Spartan Halley spectrometer pointing direction during the data-gathering periods and to provide a record of the large-scale activity of Comet Halley during the mission, including the angle of separation of the dust tail to the ion tail, nuclear outbursts, and coma asymmetries. In order to accommodate the long vacuum exposure time characteristic of Shuttle flights (a week to ten days), these two cameras will be housed in hermetically sealed containers with appropriate ports for protruding lenses.

In addition to cameras and spectrometers, the payload will also include a dedicated NSC-800 (Z80 based) microprocessor to store Comet Halley ephemeris tables and to control the experiment grating drive, ion pumps, and camera

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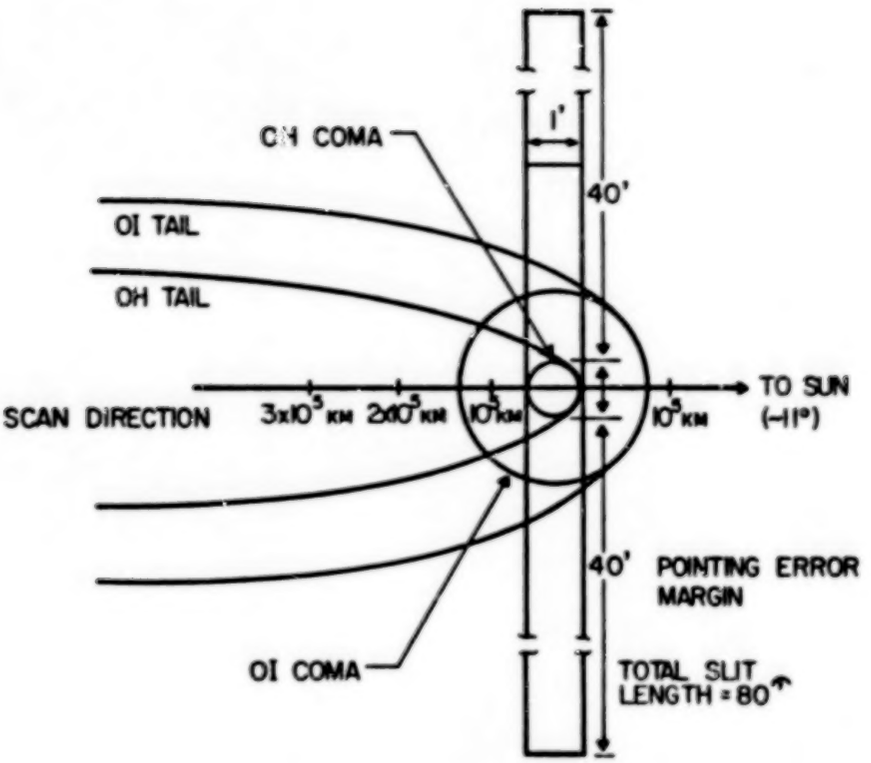

Figure 5. Observational geometry for SHM instrument slits. The projected image of the slit is 1 arcmin by 80 arcmin. Raster scans of the comet's coma and tail will be repeated throughout the observational period.

actuators. Software to control experiment bright object sensor monitoring and override protection will also be resident in the flight microprocessor. The microprocessor will communicate throughout the mission with the Spartan control system to transmit stored Comet Halley ephemeris data (such as solar offset bias and roll angle from a reference star to comet) as well to communicate other critical information.

Mission Description

The SHM operations have been designed to obtain the greatest quantity of science data possible. One consequence of the 48-hour mission duration is the ability to observe Comet Halley continuously throughout one rotation. Figure 6 depicts a summary Mission Operations Plan for a pre-perihelion launch.

After various checks in the shuttle bay, astronauts will release the Spartan carrier from its flight cradle and place it in orbit with the Remote Manipulator System. The Shuttle Orbiter will then maneuver away from the carrier. During the second and third deployed orbits, Spartan Halley will first acquire the Sun with the Suntracker, then a bright reference star, Canopus, with the startracker.

The SHM operations plan is based on a series of identical five-orbit science circuits. For the first four orbits of each circuit, the ACS will conduct a repeatable series of scans across the comet. Two-axis solar updates will also be performed on each revolution. During this period, the payload microprocessor will provide guidance information to the ACS for comet tracking and will initiate spectrometer grating drive maneuvers to guarantee wavelength-

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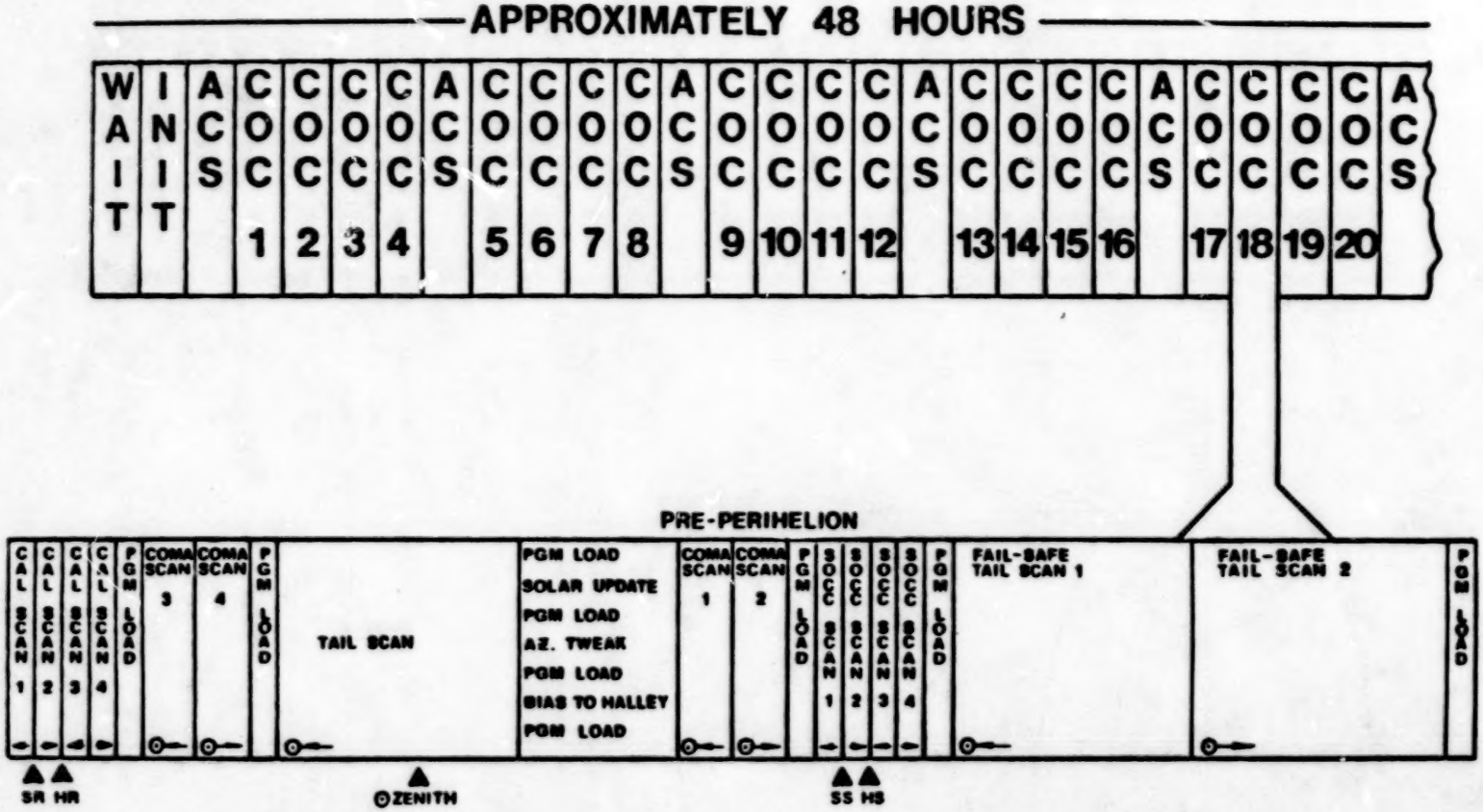

SOCC = Sun Occulted Scan

SR = Sunrise
SS = Sunset
HR = Halley Rise
HS = Halley Set

Figure 6. Operations Plan for SHM. Comet observation cycles (COC) consist of five-orbit science circuits: a series of scans across the comet will be made during four orbits of each circuit; the fifth orbit will be used to update pointing information (ACS). A typical cycle is shown in the lower box. Four 1° scans of the coma and one 4° scan of the tail are made during the daylight portion of the orbit. Four sun-occulted scans are made at the time of sunset when the comet is still above the horizon.

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coordinated observations on a variety of timescales. The fifth orbit of each circuit is devoted to a third-axis stellar update, precluding comet observations.

At the end of the 48-hour mission, the SHM carrier will cease observations and place the vehicle in a predetermined configuration to await Shuttle retrieval.

The SHM payload will be delivered to the Goddard Space Flight Center in May 1985 to be integrated into the Spartan carrier and to undergo testing. The integrated spacecraft will be shipped to Kennedy Space Flight Center in late 1985 to prepare for launch aboard Shuttle flight STS 61D in January 1986.

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SPACE MISSIONS TO COMET HALLEY: GIOTTO, VEGA, AND PLANET-A

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International Halley Watch

In March 1986, four spacecraft will encounter Comet Halley for a fly-by mission: Giotto, launched by ESA, Planet-A, launched by the Japanese space agency, and two Vega spacecraft, launched by the USSR. There are three main scientific objectives: (1) chemical composition and physical state of the nucleus, (2) physico-chemical processes involved in the coma, and (3) interaction between the comet and the solar wind. The Japanese spacecraft is mostly devoted to this last objective, while the other spacecraft have a large variety of experiments for investigating these three main questions.

Geometry of the Encounter

The configurations of the encounters are shown on Figures 1, 2, and 3. The Vega spacecraft were launched in December 1984 and will send a lander and a probe into the Venus atmosphere in June 1985, and will then be retargeted to intercept P/Halley on March 6 and March 9, 1986, respectively. The nominal distance at closest approach will be 10000 km, possibly closer for the second spacecraft. The Giotto spacecraft will be launched in July 1985 and will encounter P/Halley on March 13, 1986. The fly-by distance will be 500 to 1000 km, sunward of the nucleus. The Planet-A spacecraft will be launched in August 1985 and will approach P/Halley on March 8, 1986, at a distance of 200000 km. Another Japanese spacecraft, MST5, launched in January 1985 and also devoted to plasma experiments, will also be in the vicinity of the comet at the time of encounter.

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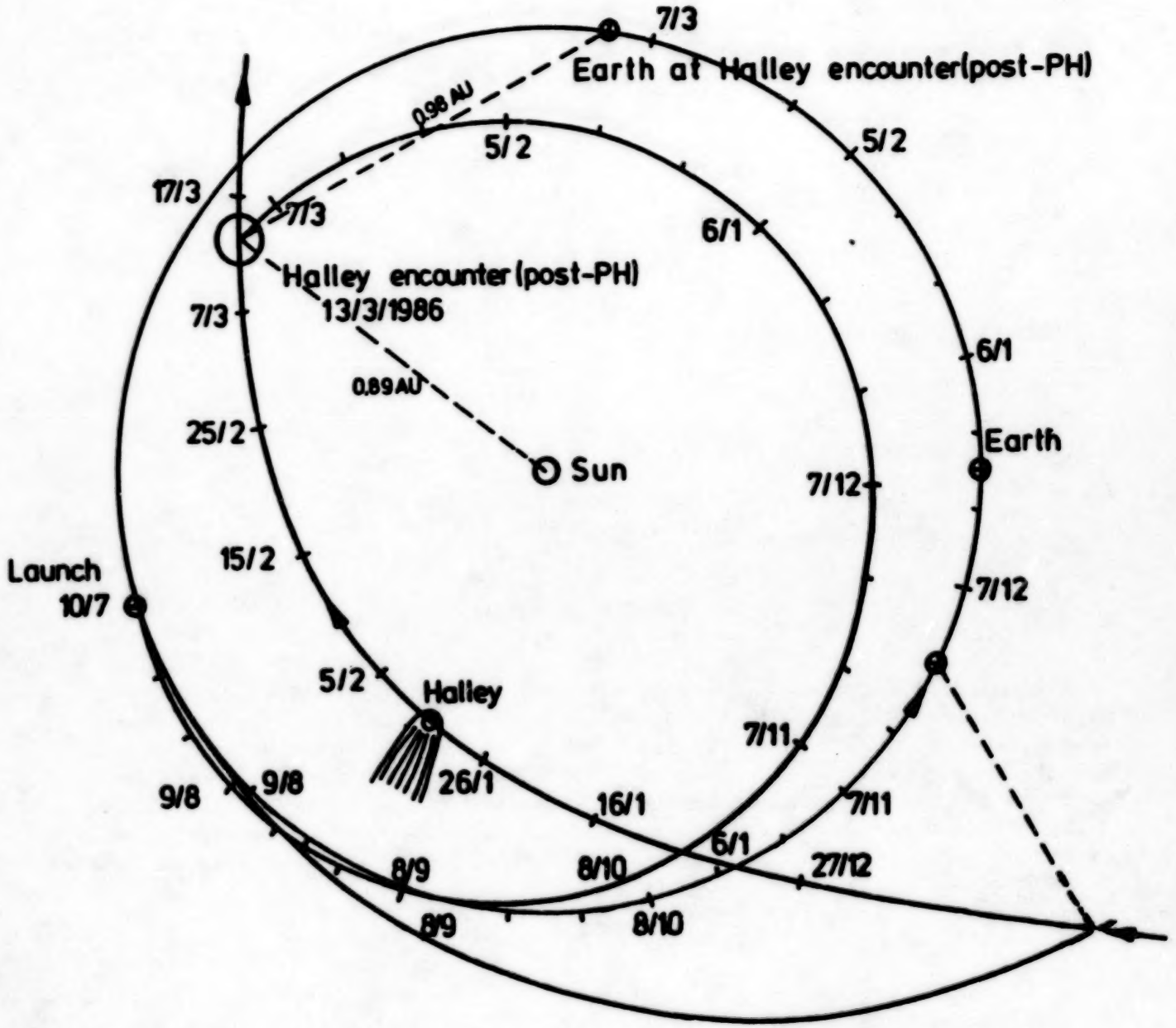

Figure 1. Giotto orbit trajectory.

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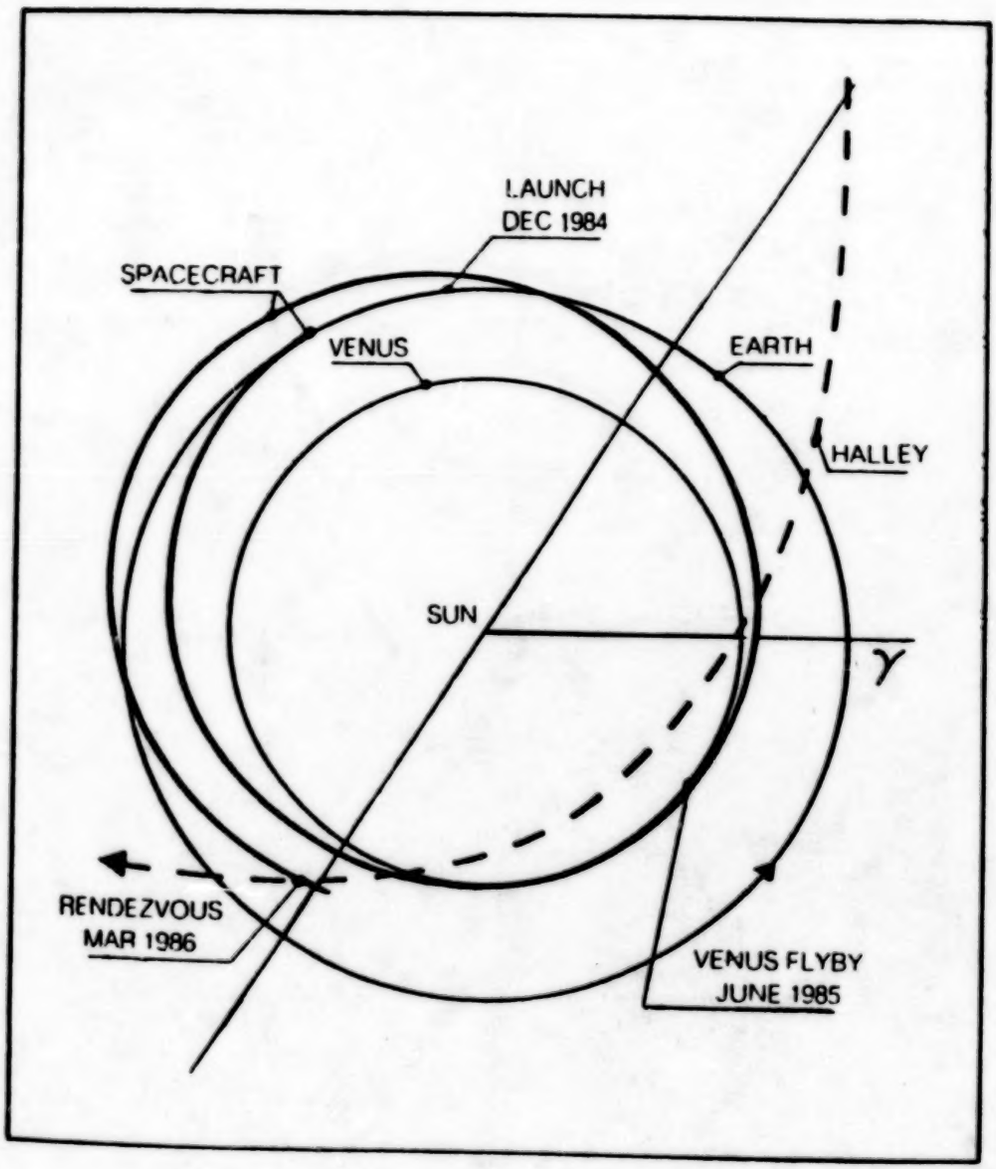

Figure 2. Vega orbit trajectory.

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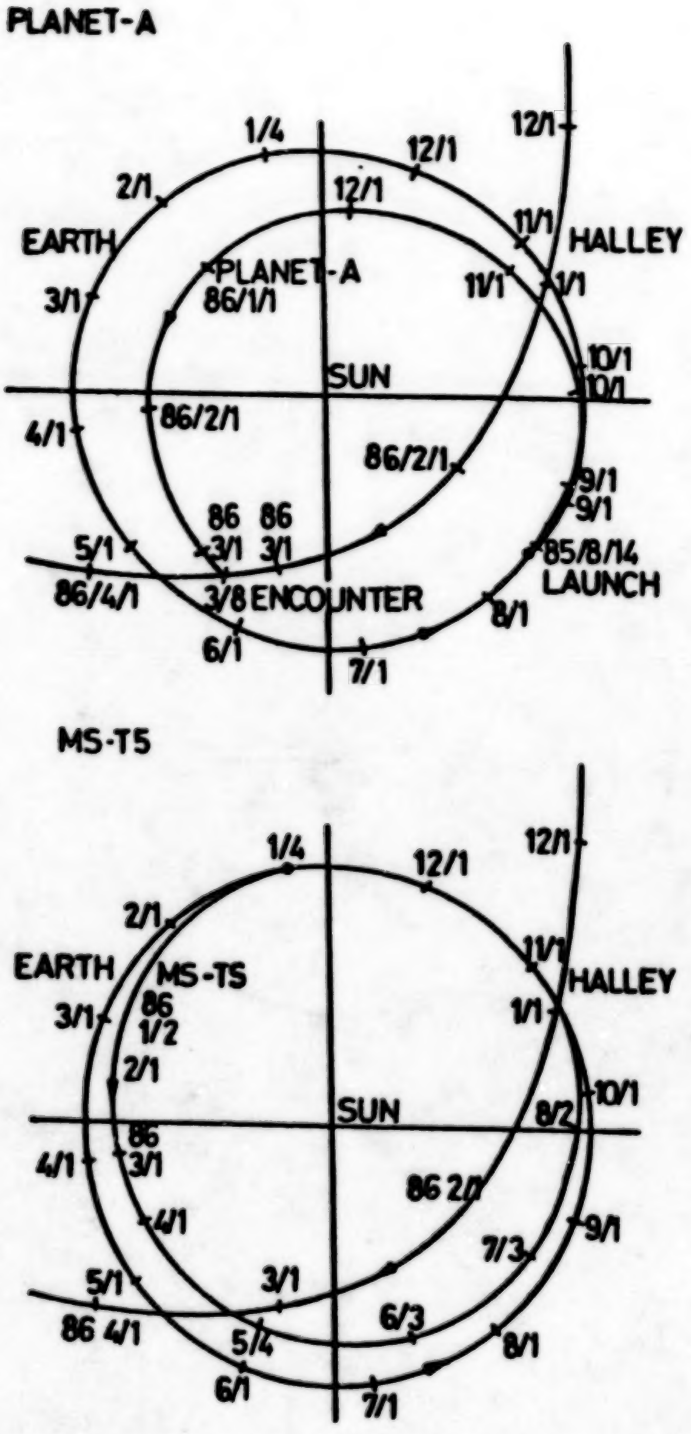

Figure 3. Planet-A (top) and MS-T5 (bottom) orbit trajectories.

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The Instruments

Giotto is a spin-stabilized spacecraft mostly devoted to in-situ measurements. Vega, in contrast, is a 3 axis-stabilized spacecraft including both in situ and remote sensing experiments. The spin-stabilized Planet-A satellite is designed for observations at larger distances. Tables 1 and 2 summarize the Giotto and Vega payloads.

TABLE 1

Scientific Experiments On Giotto

Experiment	Mass (kg)	Energy (Wh)
Camera	10.2	42
Neutral Mass Spectrometer	10.0	36
Ion Mass Spectrometer	8.2	36
Dust Mass Spectrometer	10.0	45.6
Dust Impact Detector System	2.0	7.2
Plasma Analysis (1)	3.6	14.4
Plasma Analysis (2)	2.6	12
Energetic Particles	0.4	2.0
Magnetometer	1.25	4.8
Optical Probe Experiment	1.0	4.4
TOTAL	49.25	204.4

The Cameras

The Vega narrow-field camera and the Giotto camera are comparable both in the optics and the types of detectors, and both have a large number of filters. The maximum spatial resolution is of course higher for Giotto (30 m), due to the closer approach of the spacecraft. Vega is also equipped with a wide field camera for observations of the tail. There is a hydrogen Lyman α camera aboard the Planet A spacecraft.

The Optical Spectral Instruments

Giotto has an optical probe experiment for inverting the brightness integral along the trajectory, from photometric and polarimetric measurements. Eight filters have been selected, 4 for the dust and 4 for the gas (CO, OH, CN, and C_2). The resolution of the spatial sampling will be better than 100 km.

Vega is equipped with 2 spectrometers. TKS is a 3 channel spectrometer, one for the UV (1200-3500 Å) and one for the visible (3500-9000 Å) and one for the near-IR (9000-18000 Å), which can provide high resolution spectra and/or monochromatic images. The spectral resolution is 8 Å in the UV and 15 Å in the visible. The main objective of TKS is the detailed spatial distribution of the main radicals and ions. The second spectrometer, IKS, is an infrared spectrometer: two channels give the ranges 2.5-5 μm and 6-12 μm, with a resolving power of about 50; the third channel is designed for nucleus imaging between 7 and 14 μm through a modulating grid. The main objectives of IKS are the search for parent molecules (H_2O, CO, CO_2, CH_4, etc.) and the determination of the nucleus diameter in the infrared.

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TABLE 2

Scientific Experiments On Vega

Instrument	Weight (kg)	Power (W)	TM Allocation (kb/s) Fast	Slow (20M)
Camera	29.5	50	65.536	3.072
Trichannel Spectrometer	11.3	25	12.288	
Infrared Spectrometer	18	15	2.048	4.320
Dust Mass Spectrometer	14.5	20	10.240	
Dust Impact Counter 1	1.9	2		
Dust Impact Counter 2	3	3	1.024	2.160
Neutral Mass Spectrometer	4.7	5.5	1.024	1.080
Plasma Analyzer	6.5	8	2.048	15.120
Cometary Ions in Interplanetary Medium	3.1	5	0.512	6.480
Magnetometer	4	6	0.512	2.160
LF Plasma Wave Analyzer	2.7	4.5	2.048	28.080
HF Plasma Wave Analyzer	3.0	3	0.512	15.120
Stabilized Platform	25	40	0.512	2.160
Command System	8	8		
Logic And Data Treatment	9	12		
Radiopropagation				
TOTAL	144.2	207	65.536	76.680

The Mass Spectrometers

Both Giotto and Vega have neutral mass spectrometers. The Giotto instrument, penetrating deeper into the coma, should be more powerful. It is hoped that the parent molecules of C_2, CN, NH, OH, etc. will be identified and also that the instrument will measure the CO/SO_2 ratio and its variation with the nucleus distance. Isotopic ratios should also be obtained ($^{12}C/^{13}C$, $^{16}O/^{18}O$, and possibly D/H).

There are also 2 ion mass spectrometers on Giotto. Among other results we

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can anticipate the distribution of O^+, C^+ as tracers of the solar wind interaction and, closer to the nucleus, the distributions of CO^+ and CO_2^+.

The Dust Analysers

A dust mass spectrometer is present on both Giotto and Vega, for measuring the chemical and isotopic composition of individual dust particles with sizes ranging from 0.1 to 10 μm (mass range 10^{-15} to 10^{-9}g). In addition, there is on Giotto a dust impact detector system for the analysis of large particles (limit 3×10^{-7} g) and an impact plasma detector for very small particles down to 10^{-17} g. Vega is also equipped with 2 dust impact detectors, one for the grains lighter than 10^{-11} g, the other for heavier grains.

The Plasma Experiments

Giotto, Vega and Planet A all carry several instruments for analyzing solar wind and cometary ions and electrons. In addition, Giotto and Vega have energetic particles experiments and magnetometers. There is a wave analyser on the Vega spacecraft, for the study of the ionopause and the shock front structure of the comet.

Table 3 summarizes the experiments of the 3 space missions.

The Observation Sequences

The Giotto spacecraft will start its experiments 4 hours before the time of closest approach. Data will be transmitted to Earth in real time as long as possible. There is some risk that the spacecraft will be seriously damaged at closest approach. In the case of Vega, 3 sequences are planned: 2 sequences of 2 hours each, 48 hours and 24 hours before encounter, and the observation sequence itself of 3 hours starting 2 hours before encounter and ending 1 hour after encounter. In addition, if the spacecraft survives closest approach, 2 sequences of 2 hours each will take place 24 and 48 hours after encounter.

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TABLE 3

Summary of Space Experiments On Comet Halley

	Vega	Giotto	Planet-A
Remote Sensing			
Camera (Wide Angle)	X		
Camera (Narrow Angle)	X	X	
UV Camera			X
IR sounder	X		
Photopolarimeter		X	
Three-channel spectrometer	X		
In-situ Measurements			
Neutral Mass Spectrometer	X	X	
Ion Mass Spectrometer	X	X	
Dust Mass Spectrometer	X	X	
Dust Impact Detector	X	X	
Plasma Experiments			
Solar Wind Ions	X	X	X
Electrons	X	X	X
Plasma Waves	X		
Energetic Particles	X	X	
Magnetometer	X	X	

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THE GASEOUS ACTIVITY OF COMET CROMMELIN

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During the IHW trial run on Comet Crommelin, many observers attempted to obtain photometric data. Some of these data have already been reported to the discipline specialist for photometry and polarimetry and we expect the rest to be submitted in the near future. This report includes all narrow-band data submitted to the IHW as of October 1984 and all who participated in these observations are joint authors of this report. Broad-band data were also submitted but are not discussed in this report. The detailed results will be published elsewhere but we are presenting a summary in this newsletter both because of the interest of this community in Comet Crommelin and in order to illustrate what can be achieved by a collaboration in which several observers use the standard, narrow-band filters that have been distributed to many members of the net.

Because the comet was in a very difficult position for observations from the northern hemisphere during the actual week of the trial run, we obtained observations from Lowell Observatory both before and after the trial run. During the trial run we obtained data from Perth Observatory. Each of us participated in obtaining some of the observations and preliminary reductions (extinction corrections, instrumental corrections, etc.) were carried out at our respective home institutions. The final calibrations were carried out at the University of Maryland as part of the activities of the discipline specialist. This calibration was carried out according to the prescriptions recently distributed to members of the photometry/polarimetry net. Similar calibrations (using better calibration data) will be applied by the discipline specialist's office to all data received. The data to be archived through the IHW will consist of the measured fluxes in each emission band and in the various continuum bandpasses but in order to understand the properties of the comet it was necessary for us to go several steps further. Using a variety of assumptions that have been discussed in previous papers and which will be summarized in our formal paper, we converted the fluxes of the emission bands to production rates of the gaseous species. We also used the fluxes in the continuum to calculate a quantity proportional to the production rate of solid particles.

The results are summarized in the figures. The asymmetry about perihelion is quite obvious and several theoretical models exist which predict such asymmetries. A detailed comparison with the predictions of various models can tell us about the nuclear structure. As observed in many other comets, the relative abundances of the various species do not change by large amounts; all production

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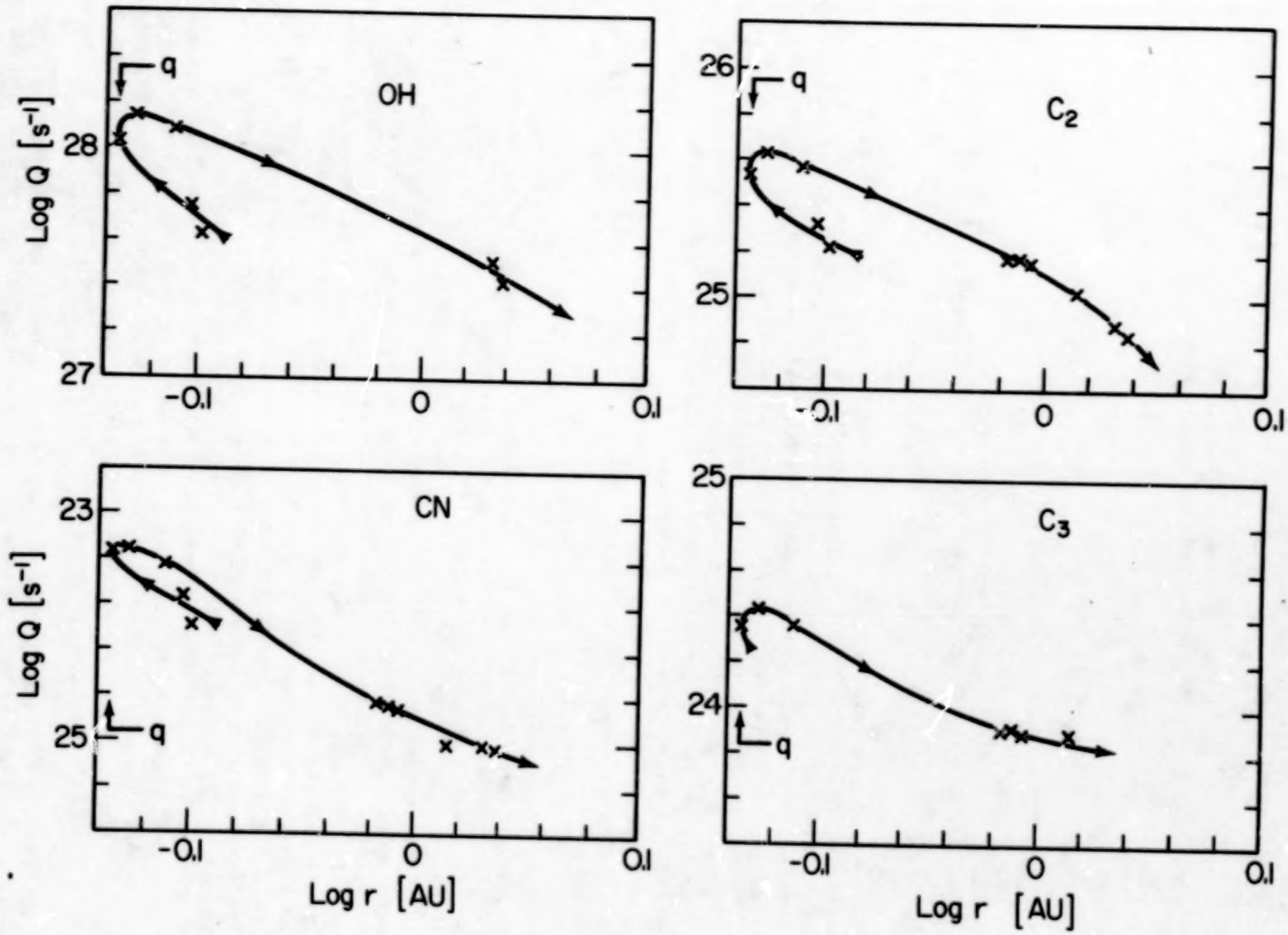

Figure 1.

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rates vary more or less together. There are variations noticeable at the 20% level which probably are statistically significant. For example, the asymmetry about perihelion seen in CN is much smaller than that seen in the remaining species. It should be noted that the data are much less complete for OH and C_3 than for CN and C_2. Because Perth Observatory is near sea level, it is not practical to obtain data on OH from that site so such observations were not attempted. During some of the observations from Lowell Observatory, data on C_3 were not obtained because of time pressures and our judgement that OH would be more important.

If we compare this comet with other comets observed in the more extensive program of Millis and A'Hearn to study many comets, we find that the abundances of trace species relative to OH seem somewhat higher than is usual but that the relative abundances of the different trace species are normal. A final point about the data is that the variation with heliocentric distance is much steeper than would be expected from any model of equilibrium vaporization of ices. This behavior, which has been seen in many comets previously, tells us immediately that the cometary nucleus does not have a surface of bare ice which is vaporizing in equlibrium with sunlight. Again there are various models which can steepen the variation to the one that we see but a detailed comparison will be required in order to decide which model provides the best fit to the data.

As noted above, complete details of these observations will be published in one of the usual refereed journals. Other collaborations of this sort will be encouraged by the discipline specialists to obtain the best possible scientific results for Comet Halley.

ON PREDICTING AND ANALYZING COMET LIGHT CURVES

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After the publication in the IHW Newsletter No. 3 of brightness predictions for the 1984 apparition of Comet P/Crommelin (Festou, 1983; Morris, 1983), numerous comments appeared in the literature because of their apparent inaccuracy, together with the interpretation of the actual 1984 light curve (Marcus, 1984; Bortle, 1984; Morris, 1984). The reading of the above-mentioned papers can lead to the conclusion that the analysis of visual observations of comets is characterized by a lot of subjectivity since so many different results are found. I am convinced that visual observations are very useful and can provide interesting information on comets. It consequently appears timely to discuss what happened in order to draw some conclusions of interest for securing the best results during the future Comet Halley observing campaign.

I have compared the magnitudes reported at the successive returns of comets many times. In most cases, I have found it very difficult to derive a single light curve, valid for all apparitions of the comet. I have thus reached the conclusion that sometimes observations are not reliable and not easily comparable with each another, mainly because of the modification in time of the notion of "visual magnitude" (magnitude of the center of coma in the past, while nowadays it refers to the entire coma) and because of the large variety of observing conditions (location of the object in the local sky of the observer, weather conditions, magnitude estimate methods used, nature of the instruments, etc.).

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The main reason for this lack of success is the fact that the activity of comets varies a great deal from one day to another and from one apparition to the next. If Morris and I performed moderately well in the papers quoted above, I believe this is due to both the poor quality and the incompleteness of the available data. In addition we assumed that the comet behaved the same way at each of its returns because of the dramatic lack of observations.

Let's address this specific assumption. Consider the light curve of P/Crommelin for its 1984 apparition (Fig. 1). It represents the heliocentric magnitude of the comet as a function of time. The long dashed curve represents a visual fit obtained by forcing this curve to be symmetrical about a vertical axis, an assumption which readily appears valid when pre- and postperihelion observations are compared by folding the light curve composed of the aperture corrected magnitudes (solid line). Our data points are either composed of single observations (small dots) or of the average of two observations (large dots). Raw data are taken from Marcus (1984) and do not significantly differ from those appearing in the I.C.Q. issue of July 1984. They have been corrected for an aperture of 16 cm (we shall discuss that choice later on). Although a slightly different mean curve could have been drawn, I believe that does not prevent us from reaching three main conclusions:

a) The mean light curve vs time was an even function (or close to such a function) during the time interval January 1 - April 2nd 1984. Maximum brightness was reached on 25 February ± 2 days.

b) No obvious large outbursts occurred (i. e., no departure by more than about 3 times the average distance to the mean curve was observed).

c) The activity of the nucleus was quite erratic and some bursts as well as some activity decreases of ~ 0.5 mag. seem to be real (Feb. 12, early March, March 28).

It does not seem possible to explain past observations by this light curve. Since most past observations underestimated the actual magnitude of the comet, especially far from perihelion, one is led to conclude that either the comet was less active in 1984 than before or that strong outbursts occurred in the past just after perihelion. Considering the accounts reported by Festou and Morris on the variation of the comet brightness and the lack of smoothness of the 1984 light curve, I prefer the second hypothesis.

Is this 1984 light curve the "good one"? As I stated above, slightly different light curves could be obtained from the same set of data points. We have compared our results with those published by other light curve analysts. Table 1 shows the results obtained by Marcus, Bortle, and Green and Morris <u>when</u> a linear fit is forced through the data points <u>and when</u> a heliocentric magnitude vs log (r_H) relationship is sought. All magnitudes were reduced to the classic standard aperture of 6.8 cm (our reduced magnitudes are on the average 0.2 to 0.3 mag. higher than those found in those studies). The examination of Table 1 suggests:

- That there is a strong pre-post perihelion asymmetry, especially on the parameter n.

- That agreement is not reached about H_o preperihelion.

- The discrepancy on n pre-T is very large and shows that either the

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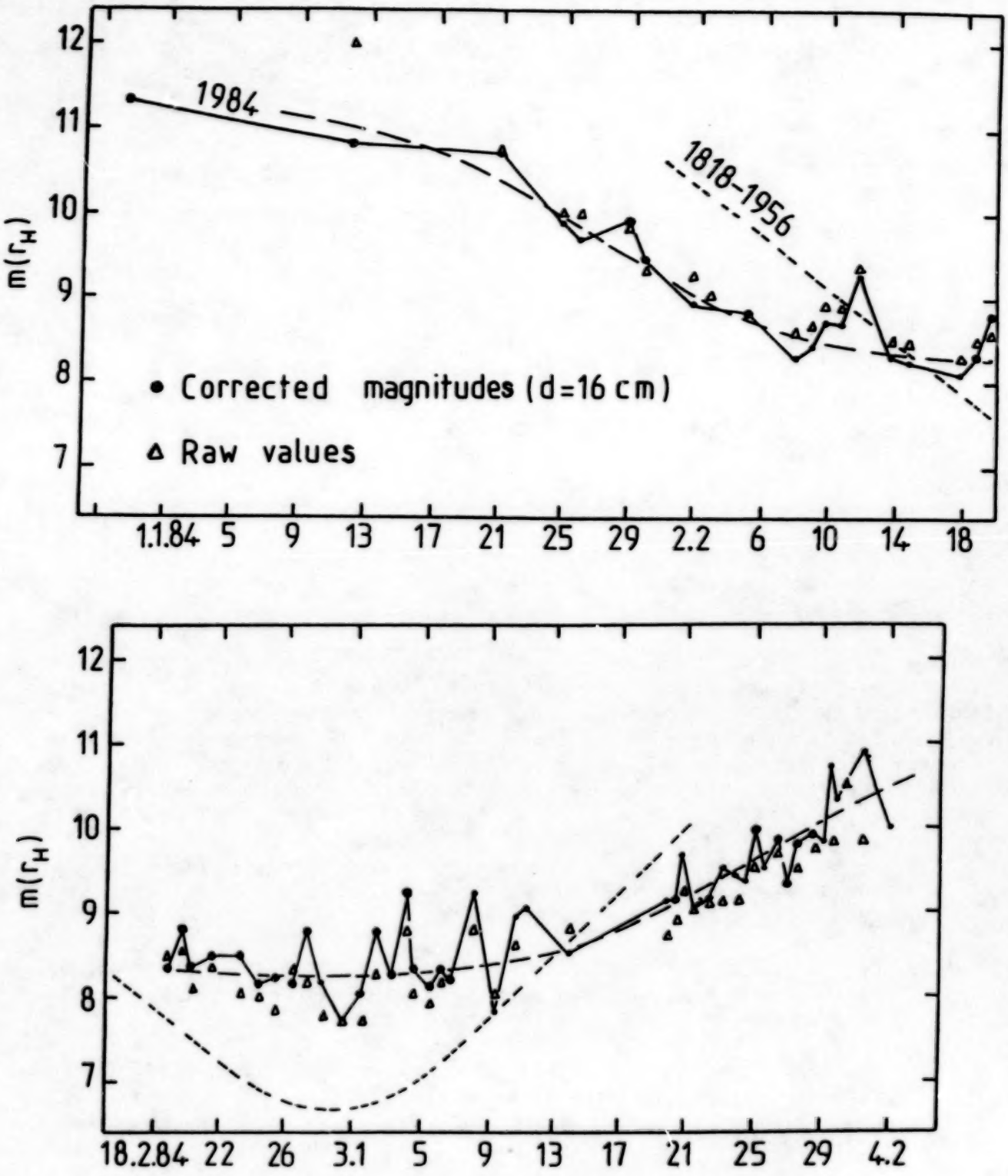

Figure 1. The light curve of Comet P/Crommelin.

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samples used differ too much or that the linear fit is a bad assumption.

- The pre and post perihelion estimates do not converge at perihelion. This is the indication that the light curve is asymmetric.

TABLE 1

Author	Pre-P			Post-P		
	H_o	n	$m(r_p)$	H_o	n	$m(r_p)$
Marcus (1984)	10.27 ± .12	5.88 ±.47	9.48	9.46 ±.06	4.88 ±.29	8.81
Bortle (1984)	10.34 ± .08	6.52 ±.31	9.47	9.38 ±.04	4.51 ±.18	8.78
Green and Morris (1984)	10.90 ± .10	8.78 ±.37	9.72	9.49 ±.04	4.36 ±.19	8.91

I have plotted in Fig. 2 the light curves whose parameters are listed in Table 1 and the light curve (bold line) deduced from the long dashed curve of Fig. 1. This latter curve is far from being symmetric about perihelion time and greatly differs from a linear function (note that a reduction to a 6.8 cm aperture would lower that curve by 0.2 to 0.3 mag.). We now understand the discrepancies found in Table 1:

a) A linear curve is a poor representation of the actual light curve. The derivations of H_o and n are very sensitive to the selected sets of data points, if such a fit is sought.

b) Before attempting the derivation of any fit by a given function, one should check that the data points are evenly distributed. Otherwise, data points should be weighted appropriately.

c) The reduction to the standard 6.8 cm aperture is not a good choice, although it does not greatly affect the results in the present case. The instruments used for observing P/Crommelin had an aperture ranging from 7 cm to 40 cm, and most amateur instruments were of larger size than this selected standard. The average value for our set of data points is 16 cm. Reducing the magnitudes to that aperture minimizes the corrections made to the raw data. This is especially important when one considers that the magnitude estimate method employed is unknown and thus not adequately corrected.

d) In the case where r_H slowly varies with time, a $m(r_H)$ vs time plot should be preferred. It is clear that the use of log (r_H) as a variable near perihelion is not good since r_H does not vary much between February

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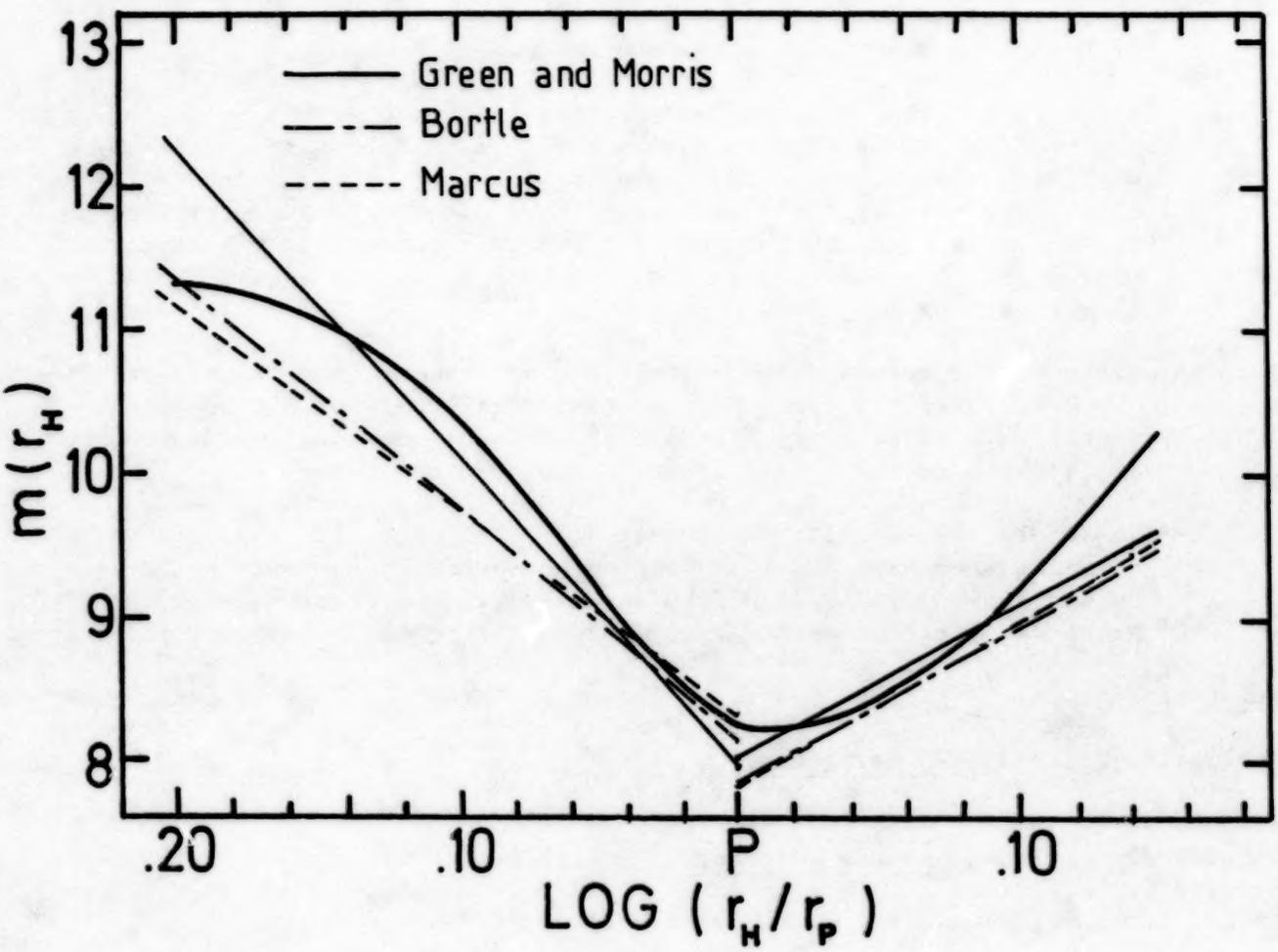

Figure 2. The light curves matching the parameters in Table 1.

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1st and March 10th ($0.74 < r_H < 0.8$ AU) : in this case, the information contained in the data obtained around perihelion time is lost.

Our conclusions, in order to get the best results from amateur astronomers' observations, can be summarized as follows:

1- Use reflectors rather than refractors. Aperture corrections will be minimized. Otherwise, when possible, attempt obtaining quasi-simultaneous magnitude estimates with the two types of instruments and/or with various magnitude estimate methods.

2- Light curves should be analyzed taking into account the nature of the orbit of the comet: if r_H does not vary much during the period of analysis, a mag. vs $\log(r_H)$ analysis will lead to a meaningless value of n. The real variable is in fact H_o. One should remember that the renewal time constant for the C_2 cloud is of the order of one day at one AU and that consequently, data points do not necessarily fall on a slowly varying function.

3- Since most comets observed by amateur astronomers have magnitudes in the 8-12 range, correction to a standard aperture of 6.8 cm is not justified. An aperture standard of 15-16 cm would be preferable, for it is the mean instrument aperture used by the observers.

4- To secure the best light curve of Halley's Comet, it is urgent to organize a campaign so that instrument corrections (what is the aperture correction for binocular, Schmidt-Cassegrain telescopes, etc.) and magnitude estimate method differences will be accurately determined.

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COMMENTS ON "A PHOTOMETRIC LIGHT CURVE OF COMET HALLEY 1910 II" AND "ON PREDICTING AND ANALYZING COMET LIGHT CURVES"

Charles S. Morris
International Comet Quarterly

The above mentioned papers (Magazzu and Strazzulla, 1984; Festou, 1985) both deal with aspects of analyzing photometric data of comets. While each paper makes some interesting points, other aspects of these papers require comment.

The paper by Magazzu and Strazzulla (1984) documents previously unpublished magnitude data on the photometric nucleus of Comet Halley in 1910. The most interesting aspect of these data are the apparent nuclear outbursts which Magazzu and Strazzulla say occurred on April 19, April 25 and May 12, 1910.

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Modern visual observers know that nuclear outbursts are characterized by the appearence of a bright star-like condensation which expands into a disk over a period of days. These outbursts are associated with the emission of dust into the coma. The light curve constructed by the authors does strongly suggest that outbursts did occur on the latter two dates. It is difficult to determine whether or not an outburst occurred on April 19th because there are no data previous to this date. It would be most interesting to correlate these newly found data with other observations of the photometric nucleus to see if these outbursts could be confirmed.

In addition to constructing the light curve, Magazzu and Strazzulla perform rather extensive regression analyses to determine the best fit of the nuclear brightness estimates. It is not clear that these analyses tell us anything about the physical characteristics of the comet. The simple fact is that we do not know what the photometric nucleus represents. By changing instruments and/or magnification, the visual observer can change the apparent brightness of the photometric nucleus. The higher the magnification, the fainter the photometric nucleus. We are neither talking about the real nucleus nor the total brightness of the comet, but something (rather ill-defined) in between.

In their regression analysis the authors explain the shape of the light curve by invoking the (yet to be proven) visual delta effect. This effect applies to diffuse objects. Why then does it apparently explain the brightness variation of a "stellar" photometric nucleus? The "delta effect" may work in this case because the true nucleus is not being observed. As mentioned earlier, the brightness of the photometric nucleus is correlated with magnification being used. By increasing the magnification (or reducing the comet's distance), the observer essentially sees through more of the coma surrounding the nucleus; thus, the photometric nucleus appears intrinsically fainter. This may be the effect that the authors modeled in their analysis; it is not the delta effect commonly referred to in the literature.

The paper by Festou (1985) discusses the light curve of periodic Comet Crommelin during its recent apparition. On the basis of his results he proposes some recommendations for the visual observation and analysis of Comet Halley and other comets. In general most of the points made by Festou are good ones. His conclusions concerning P/Crommelin's light curve are similar to those obtained by Morris (1984) and Green and Morris (1984). However, Festou does make some suggestions which require further discussion.

Festou suggests that the standard aperture to which comet brightness estimates are reduced be changed from 6.8 cm to 15 or 16 cm. Prior to accepting such a suggestion, it is important to look at the consequences of the recommendation. The standard aperture is the aperture to which visual magnitude estimates are corrected to obtain a homogeneous set of data. The corrections are made by applying an aperture correction. This author has shown (Morris, 1973) that there are different corrections required for observations made with refractors and reflectors. It is also obvious from experience that the required correction may vary from comet to comet, is probably a function of how condensed the comet appears, and varies from one observer to the next. Thus, the average corrections proposed by this author (Morris, 1973) may be significantly in error in a particular situation.

The choice of a standard aperture should minimize any potential error introduced by inaccuracies in the aperture correction. To determine which

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standard aperture should be used an error analysis was performed assuming a 50 percent error in the standard aperture correction (Morris, 1973). For the analysis three commonly used amateur instruments are assumed: the naked eye (assumed to be a refractor), a 5 cm refractor (e.g., a finder or perhaps binoculars) and a 32 cm reflector (a moderately large amateur instrument). A large refractor was not assumed because they are rarely used today.

As the table illustrates, a standard aperture of 6.8 cm limits the potential error to less than 0.3 magnitude for all three instruments, which is similar to the typical observational error. In contrast, a standard aperture of 15 cm substantially increases the error for two of the instruments while only modestly improving the result for the large reflector. Why worry about naked eye and small refractor/binocular observations? These are the instruments used when comets are bright. The majority of P/Halley observations will be made with small instruments when the comet is bright. To significantly decrease the accuracy of these observations to gain only a slight improvement for large reflectors is not appropriate. A standard aperture of 6.8 cm (which is about the average of typical binocular sizes), while not perfect in all cases, is a much better choice than 15 or 16 cm.

STANDARD APERTURE ERROR ANALYSIS

	Proposed Standard Apertures	
Instrument	6.78 cm	15 cm
Naked Eye	0.20 mag.	0.47 mag.
5 cm refractor	0.06 mag.	0.33 mag.
32 cm reflector	0.24 mag.	0.14 mag.

Another conclusion that Festou draws is that a different photometric formula should be used. He points out, as did this author (Morris, 1984), that the standard power-law formula did not represent the P/Crommelin data very well. To date no one formula universally works for all comets. The formula proposed by Festou should be evaluated to determine 1) if it tells us something about the physical properties of the comet and 2) if data from a wide range of comets can be represented by the formula. If it satisfies these conditions, the formula should be adopted.

As a final thought, I would like to recommend that analysts consult the data archives of the International Comet Quarterly (ICQ) when they wish to study comet light curves. A primary goal of the ICQ is the archiving of cometary brightness data, particularly visual observations. Data obtained from other sources may be incomplete and possibly subject to the selective bias of other authors.

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A GUIDE TO EXTINCTION AND DIFFERENTIAL REFRACTION

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Tempe, AZ 85287

Atmospheric extinction and differential refraction are two phenomena which ground-based observers must contend with at all times. Both are relatively small effects when observing objects at small zenith angles (except for extinction below ~4000 Å), while at large zenith angles the effects are much more extreme. Tabulated in Tables 1 and 2 are approximate values of extinction and differential refraction at three elevations (sea level, 7200 ft - several major observatories - and 13800 ft - Mauna Kea) as functions of both wavelength and altitude. The calculation used for the extinction values includes contributions of three components: (1) aerosols, (2) ozone absorption, and (3) Rayleigh scattering. Each of these components is determined as a function of wavelength, while the aerosol and Rayleigh scattering contributions are also dependent on elevation. The differential refraction calculation takes the elevation dependence into account by means of an atmospheric pressure component, but does not include a temperature component. The subroutines used in the extinction calculations were written by Bradley Peterson of Ohio State University, and the refraction routine was written by Bill Cochran and provided by Anita Cochran, both at the University of Texas.

For example, consider observations of P/Crommelin during the trial run. A typical altitude of observations was approximately 20°. For an elevation of 7000 ft. and wavelengths shortward of 3500 Å the extinction is greater than 2 magnitudes and the differential refraction is greater than 3 arc sec (referred to λ5500). Spectrophotometric observations using a 3-4 arc sec diameter entrance aperture would effectively sample different regions of the coma at different wavelengths. In addition, a standard star measured under the same conditions and centered in the aperture at 5500 Å would be missed entirely at short wavelengths! The problems encountered due to refraction are less severe for narrow-band filter photometry because of the larger apertures typically employed, but at sufficiently high air masses can still be significant. The interpretation of narrow-band imaging of the coma is also complicated by these effects.

Finally, note that these tables have been created to be used as a guide and not as definitive values to be used in data reduction and analysis, because the actual values are affected by many additional factors, such as physical location, seasonal and diurnal variations, volcanic dust, and temperature.

THE HALLEY FOLLIES, ACT I

Stephen J. Edberg
International Halley Watch

Just as occurred in 1910, public, media, and entrepreneurial interest in Comet Halley is on the rise. Media articles giving an address for further information sparks large amounts of mail from the public. Entrepreneurs are offering Halley-related items from baseball caps and T-shirts to special telescopes. Many travel groups are offering tour packages to the southern hemisphere after perihelion. (Material has been prepared at the Pasadena Lead

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TABLE 1

DIFFERENTIAL REFRACTION (IN ARC SECONDS)

ELEVATION OF 0 M (SEA LEVEL)

ALTITUDE (DEGREE)	AIR-MASS	WAVELENGTH (ANGSTROM) 3000	3200	3400	3600	3800	4000	4500	5000	5500	6000	6500	7000	8000	9000	10000
90.	1.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
75.	1.04	0.8	0.7	0.6	0.4	0.4	0.3	0.1	0.1	0.0	0.0	-0.1	-0.1	-0.2	-0.2	-0.2
60.	1.15	1.7	1.4	1.2	1.0	0.8	0.6	0.3	0.1	0.0	-0.1	-0.2	-0.3	-0.3	-0.4	-0.5
45.	1.41	3.0	2.5	2.1	1.6	1.4	1.1	0.6	0.2	0.0	-0.2	-0.3	-0.5	-0.6	-0.7	-0.8
30.	1.99	5.2	4.3	3.6	2.9	2.4	1.9	1.0	0.4	0.0	-0.3	-0.5	-0.8	-1.0	-1.2	-1.4
20.	2.90	8.2	6.8	5.7	4.5	3.8	3.0	1.5	0.7	0.0	-0.5	-0.8	-1.2	-1.6	-2.0	-2.2
15.	3.82	11.2	9.2	7.7	6.2	5.1	4.1	2.1	0.9	0.0	-0.7	-1.2	-1.7	-2.2	-2.7	-3.0
10.	5.60	16.9	14.0	11.7	9.3	7.8	6.2	3.2	1.4	0.0	-1.1	-1.8	-2.6	-3.4	-4.1	-4.6
5.	10.21	34.2	28.3	23.6	18.8	15.7	12.5	6.4	2.8	0.0	-2.1	-3.5	-5.2	-6.8	-8.2	-9.2

ELEVATION OF 2200 M (7200 FT)

ALTITUDE (DEGREE)	AIR-MASS	WAVELENGTH (ANGSTROM) 3000	3200	3400	3600	3800	4000	4500	5000	5500	6000	6500	7000	8000	9000	10000
90.	1.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
75.	1.04	0.6	0.5	0.4	0.3	0.3	0.2	0.1	0.1	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.2
60.	1.15	1.3	1.1	0.9	0.7	0.6	0.5	0.2	0.1	0.0	-0.1	-0.1	-0.2	-0.3	-0.3	-0.4
45.	1.41	2.3	1.9	1.6	1.3	1.0	0.8	0.4	0.2	0.0	-0.1	-0.2	-0.3	-0.5	-0.6	-0.6
30.	1.99	4.0	3.3	2.7	2.2	1.8	1.4	0.7	0.3	0.0	-0.2	-0.4	-0.6	-0.8	-1.0	-1.1
20.	2.90	6.3	5.2	4.3	3.5	2.9	2.3	1.2	0.5	0.0	-0.4	-0.6	-1.0	-1.3	-1.5	-1.7
15.	3.82	8.5	7.0	5.9	4.7	3.9	3.1	1.6	0.7	0.0	-0.5	-0.9	-1.3	-1.7	-2.1	-2.3
10.	5.60	12.9	10.7	8.9	7.1	5.9	4.7	2.4	1.1	0.0	-0.8	-1.3	-2.0	-2.6	-3.1	-3.5
5.	10.21	26.1	21.6	18.0	14.4	12.0	9.5	4.9	2.2	0.0	-1.6	-2.7	-4.0	-5.2	-6.3	-7.0

ELEVATION OF 4200 M (13800 FT)

ALTITUDE (DEGREE)	AIR-MASS	WAVELENGTH (ANGSTROM) 3000	3200	3400	3600	3800	4000	4500	5000	5500	6000	6500	7000	8000	9000	10000
90.	1.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
75.	1.04	0.5	0.4	0.3	0.3	0.2	0.2	0.1	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1
60.	1.15	1.0	0.8	0.7	0.6	0.5	0.4	0.2	0.1	0.0	-0.1	-0.1	-0.2	-0.2	-0.2	-0.3
45.	1.41	1.8	1.5	1.2	1.0	0.8	0.6	0.3	0.1	0.0	-0.1	-0.2	-0.3	-0.4	-0.4	-0.5
30.	1.99	3.1	2.5	2.1	1.7	1.4	1.1	0.6	0.3	0.0	-0.2	-0.3	-0.5	-0.6	-0.7	-0.8
20.	2.90	4.9	4.0	3.4	2.7	2.2	1.8	0.9	0.4	0.0	-0.3	-0.5	-0.7	-1.0	-1.2	-1.3
15.	3.82	6.6	5.5	4.6	3.6	3.0	2.4	1.2	0.5	0.0	-0.4	-0.7	-1.0	-1.3	-1.6	-1.8
10.	5.60	10.0	8.3	6.9	5.5	4.6	3.7	1.9	0.8	0.0	-0.6	-1.0	-1.5	-2.0	-2.4	-2.7
5.	10.21	20.2	16.7	13.9	11.2	9.3	7.4	3.8	1.7	0.0	-1.3	-2.1	-3.1	-4.0	-4.9	-5.4

TABLE 2

EXTINCTION (IN MAGNITUDES)

ELEVATION OF 0 M (SEA LEVEL)

ALTITUDE (DEGREE)	AIR-MASS	WAVELENGTH (ANGSTROM) 3000	3200	3400	3600	3800	4000	4500	5000	5500	6000	6500	7000	8000	9000	10000
90.	1.00	2.0	1.6	1.3	1.1	1.0	0.9	0.7	0.6	0.5	0.5	0.4	0.3	0.3	0.3	0.2
75.	1.04	2.0	1.7	1.4	1.2	1.0	0.9	0.7	0.6	0.5	0.5	0.4	0.4	0.3	0.3	0.2
60.	1.15	2.3	1.8	1.5	1.3	1.2	1.0	0.8	0.7	0.6	0.5	0.5	0.4	0.3	0.3	0.3
45.	1.41	2.8	2.3	1.9	1.6	1.4	1.2	1.0	0.8	0.7	0.6	0.6	0.5	0.4	0.4	0.3
30.	1.99	3.9	3.2	2.7	2.3	2.0	1.8	1.4	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.5
20.	2.90	5.7	4.6	3.9	3.3	2.9	2.6	2.0	1.6	1.4	1.3	1.1	1.0	0.8	0.7	0.7
15.	3.82	7.4	6.1	5.1	4.4	3.8	3.4	2.6	2.2	1.9	1.7	1.5	1.3	1.1	1.0	0.9
10.	5.60	10.9	8.9	7.5	6.4	5.6	4.9	3.8	3.2	2.8	2.5	2.2	1.9	1.6	1.4	1.3
5.	10.21	19.9	16.3	13.7	11.7	10.2	9.0	7.0	5.8	5.1	4.6	4.0	3.5	3.0	2.6	2.3

ELEVATION OF 2200 M (7200 FT)

ALTITUDE (DEGREE)	AIR-MASS	WAVELENGTH (ANGSTROM) 3000	3200	3400	3600	3800	4000	4500	5000	5500	6000	6500	7000	8000	9000	10000
90.	1.00	1.2	0.9	0.7	0.6	0.5	0.4	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
75.	1.04	1.2	0.9	0.7	0.6	0.5	0.4	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
60.	1.15	1.3	1.0	0.8	0.7	0.6	0.5	0.3	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1
45.	1.41	1.6	1.3	1.0	0.8	0.7	0.6	0.4	0.3	0.3	0.2	0.2	0.2	0.1	0.1	0.1
30.	1.99	2.3	1.8	1.4	1.2	1.0	0.8	0.6	0.4	0.4	0.3	0.3	0.2	0.2	0.1	0.1
20.	2.90	3.3	2.6	2.1	1.7	1.4	1.2	0.8	0.6	0.5	0.5	0.4	0.3	0.2	0.2	0.2
15.	3.82	4.4	3.4	2.8	2.2	1.9	1.6	1.1	0.8	0.7	0.6	0.5	0.4	0.3	0.3	0.2
10.	5.60	6.4	5.0	4.0	3.3	2.7	2.3	1.6	1.2	1.1	1.0	0.7	0.6	0.4	0.4	0.3
5.	10.21	11.8	9.2	7.4	6.0	5.0	4.2	2.9	2.2	1.9	1.7	1.4	1.1	0.8	0.7	0.6

ELEVATION OF 4200 M (13800 FT)

ALTITUDE (DEGREE)	AIR-MASS	WAVELENGTH (ANGSTROM) 3000	3200	3400	3600	3800	4000	4500	5000	5500	6000	6500	7000	8000	9000	10000
90.	1.00	0.8	0.6	0.5	0.4	0.3	0.3	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
75.	1.04	0.9	0.7	0.5	0.4	0.3	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0
60.	1.15	0.9	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0
45.	1.41	1.2	0.9	0.7	0.6	0.5	0.4	0.2	0.2	0.2	0.1	0.1	0.1	0.0	0.0	0.0
30.	1.99	1.6	1.3	1.0	0.8	0.6	0.5	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.0	0.0
20.	2.90	2.4	1.8	1.4	1.1	0.9	0.8	0.5	0.4	0.3	0.3	0.2	0.1	0.1	0.1	0.1
15.	3.82	3.1	2.4	1.9	1.5	1.2	1.0	0.7	0.5	0.4	0.4	0.3	0.2	0.1	0.1	0.1
10.	5.60	4.6	3.5	2.8	2.2	1.8	1.5	1.0	0.7	0.6	0.6	0.4	0.3	0.2	0.1	0.1
5.	10.21	8.4	6.4	5.1	4.0	3.3	2.7	1.7	1.3	1.1	1.0	0.7	0.5	0.3	0.2	0.2

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Center to assist observer/travellers in selecting a tour.)

And now the doomsayers have gotten into the act. A registered commodity advisor in Arizona claims that his timing indicators are focusing their strength in February 1985 as significant. He backs this up with a report he claims is suppressed by the Western press: The report says our Russian colleagues have discovered a 75 mile diameter asteroid orbiting Halley's Comet (!?) which could collide with the Earth this February. By the time you read this, "Ivan the Terrible" as it's called, will apparently be having its effect, along with sunspots, on the market. Investors be warned!

NEW INFORMATION SOURCES

Announcements or samples of the following sources of comet information have been received at the JPL Lead Center:

Halley's Comet - A Bibliography, compiled by Ruth S. Freitag, Library of Congress (Washington, D. C.).

Halley's Comet, 1755-1984: A Bibliography, compiled by Bruce Morton, Greenwood Press (Westport, CT).

Comet Halley Returns, A Teacher's Guide 1985-1986, by R. D. Chapman and R. L. Bondurant, Jr., Superintendent of Documents, U.S.G.P.O. (Washington, D.C.).

Comets, a children's book by F. M. Branley, Harper and Row Junior Books Group (New York).

La Cometa di Halley, by P. Maffei, Mondadori (Milano).

Os Cometas, by N. Travnik, Papirus (Campinas, Brasil).

Komeetat, by Kari Kaila, Ursan (Helsinki).

Comets and Comet Halley, a slide set compiled by J. C. Brandt, Astronomical Society of the Pacific (San Francisco).

ASTROMETRY

Recent Astrometric Observations Of Comets Halley And Giacobini-Zinner: After its solar conjunction during the summer of 1984, Comet Halley was first observed by T. Seki in Japan on September 22, 1984 and again four nights later at magnitude 20.5. H. Spinrad and S. Djorgovski at Kitt Peak Observatory in the U.S.A. observed the comet at magnitude 21.3 on September 25 and again two nights later at magnitude 20.3. On October 1, Graser observed the comet at the Calar Alto Observatory in Spain and on October 24, H. Pedersen and his collaborators reported two positions of the comet. Kitt Peak observations were also made by G. Djorgovski, P. Wehinger and M.J.S. Belton on October 30 and by A. Crotts (University of Chicago, U.S.A.) on November 17. Measurements of the four Kitt Peak observations were made by M.J.S. Belton. Zhang Bairong of Yunnan Observatory in the People's Republic of China reported an observation for November 4, 1984. Five astrometric positions made on November 25-26, 1984 by V. Shkodrov and T. Boney at the Bulgarian National Observatory and another position by

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T. S[illegible] on November 29 (20th magnitude) were also received.

The most recent astrometric observations of Comet Giacobini-Zinner were made on July 21-22, 1984 by J. Brodie, P. McCarthy and J. T. Clarke at the Cerro Tololo Interamerican Observatory (approximately magnitude 23). Comet Giacobini-Zinner should come out of solar conjunction and be once again observable in early 1985.

Halley and Giacobini-Zinner Star Catalogs: We have received a total of 42 requests for Halley and Giacobini-Zinner reference star catalogs. These catalogs have been supplied on magnetic tape, hard copy printouts and ten different formats for microcomputer floppy disks. While the variety of microcomputer operating systems and disk formats in use today took us by surprise, Ray Wimberly has managed to write the requested disks in the majority of cases and these disks have been distributed. Observers who intend to make astrometric observations of either comet are strongly encouraged to request these reference star catalogs for their data reductions. Upon request to D. K. Yeomans, we can also provide plate reduction programs (developed by R. S. Harrington and B. Manning) and a star plotting program (developed by P. Mack).

Astrometry Workshop Proceedings Published And Distributed: The Proceedings of our Astrometry Workshop, held June 18-19, 1984 in Garching, FRG, have been printed and distributed to every member in the Astrometry Network. These Proceedings include 27 papers on recent developments in cometary physics, astrometric observation techniques, reference star catalogs, plate reduction procedures, and recent orbit determination results on both Comets Halley and Giacobini-Zinner. In addition, there are recommendations for observation and data reduction procedures, the proper use of reference star catalogs, and the suggested formats and methods for the efficient and timely transferring of data from the observers to the orbit determination centers. By using the suggested procedures and formats, the astrometric data set used in the orbit determination process should be as uniform and accurate as modern techniques allow.

Giacobini-Zinner Handbook In Preparation: In an effort to make observers more aware of the opportunity and need for ground based observations of Comet Giacobini-Zinner, D. K. Yeomans and J. C. Brandt (and several contributors) are preparing an observer's guide. This guide will outline the International Cometary Explorer (ICE) mission to Comet Giacobini-Zinner, present a physical model for the comet and provide observing circumstances and ephemerides for the 1985-1986 apparition. This observer's guide should be published in early 1985 and will be distributed to members of the International Halley Watch.

D. K. Yeomans
R. M. West
R. S. Harrington
B. G. Marsden

LARGE-SCALE PHENOMENA

The number of observatories in the Large-Scale Phenomena (L-SP) Network is now in excess of 90, and the "island network" (see Newsletter #5) of small portable Schmidt cameras which will fill in Southern hemisphere coverage gaps (in 1986 March-April) is rapidly taking shape. Highlights of the small Schmidt

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(island) network are as follows. In the Pacific, Drs. William Liller and Allen Seltzer will obtain observations from Easter Island and the Galapagos, respectively, and Mr. Pat Malloy of TRW Company will observe from Tahiti, thereby filling in the largest single hole in the L-SP net for 1986 early-March. In the South Atlantic, Dr. Jonathan Shanklin and colleagues from the British Antarctic Survey (BAS) will photograph the comet from Halley Bay, Antarctica, and observations will also be obtained by British Meteorological Office (BMO) personnel on St. Helena. The Societe Astronomique de France (S.A.F.), under the direction of Dr. A. C. Levasseur-Regourd, has agreed to observe from Reunion Island in the Indian Ocean. Negotiations are currently under way with the South African Weather Bureau (SAWB) to observe from Gough and Marion Islands in the S. Atlantic and Indian Oceans, respectively.

Several of our personnel (Rahe, Brandt, and Niedner), and Dr. Bertram Donn (NASA/GSFC, Greenbelt, MD), are involved in the publication of a photographic atlas of Comet Halley 1910II, to be comprised of approximately 500 images from many observatories around the world who have graciously forwarded either original plates, film copies, or prints. It will be very interesting and scientifically important to compare the 1910 material with that obtained in 1985-1986. The 1910 photographs show a very high level of plasma tail activity, which is not surprising in view of the large amplitude high-speed streams (with embedded magnetic sector boundaries) which are known to characterize the mid-descending branch of the solar cycle. Although the 1985-1986 apparition will be closer to a solar minimum, streams and sector structure are still expected to produce major and rapid temporal variations in the plasma tail. Many of the current theories of plasma processes in comets are based at least in part on the Halley images coming out of 1910, and on inferences about the solar wind at that time. The upcoming apparition offers a unique opportunity to test these theories with an unprecedentedly complete set of images, combined with crucial supporting data obtained with interplanetary satellites (e.g., solar wind and interplanetary magnetic field measurements).

Topics to be covered in the next newsletter (as well as our next L-SP Circular) include plans for observing comet P/Giacobini-Zinner, which will be intercepted by the International Cometary Explorer (ICE) on 1985 September 11, and more details on Halley.

J. C. Brandt
M. B. Niedner
J. Rahe

SPECTROSCOPY AND SPECTROPHOTOMETRY

Spectra of Comet Halley: 1984

Slit spectra of Comet Halley were obtained with two telescopes in Arizona during 1984. Figure 1 was obtained with the Kitt Peak National Observatory 4 m telescope and cryogenic camera 1984 Feb. 4 (UT date). Subsequent spectra have been secured Oct. 30 with the KPNO 4 m and on Nov. 26 (Figure 2) with both the KPNO 4 m and the 4.5 m Multi-Mirror Telescope (MMT). The observing program on the KPNO 4 m telescope is the collaborative work of M. Belton (KPNO), H. Spinrad (Berkeley), P. Wehinger, S. Wyckoff, and D. Yeomans (JPL). A preliminary report on the 4 Feb. 1984 observations was presented by M. Belton and collaborators at the Kona, Hawaii meeting of the American Astronomical Society/Division of

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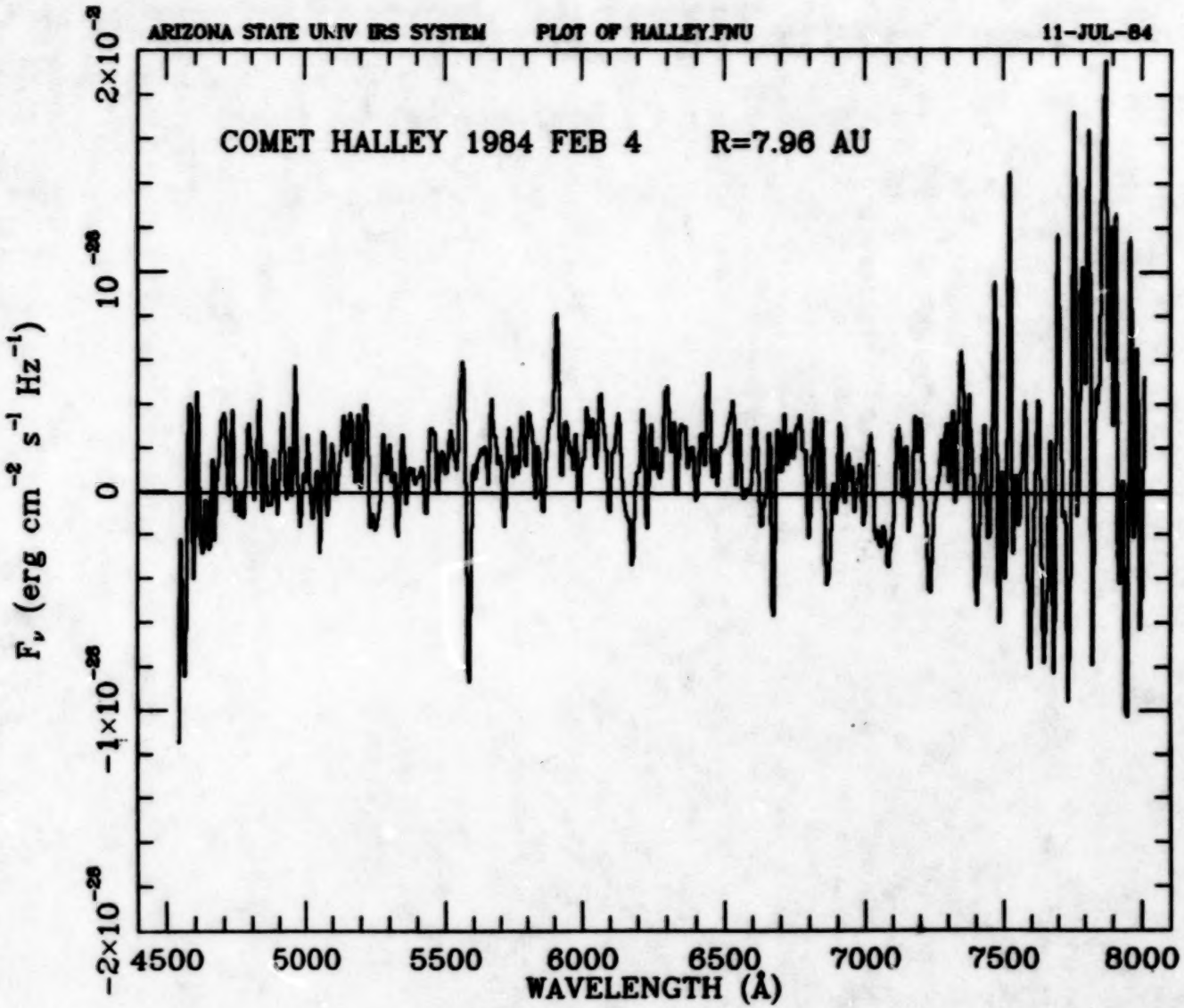

Figure 1. Spectrum of P/Halley, 4 Feb. 1984 UT, obtained with KPNO 4-m telescope and cryogenic camera, integration 3600 seconds, spectral resolution = 15 Å, r = 7.96 AU, Δ = 7.21 AU, and V = 23.5 mag.

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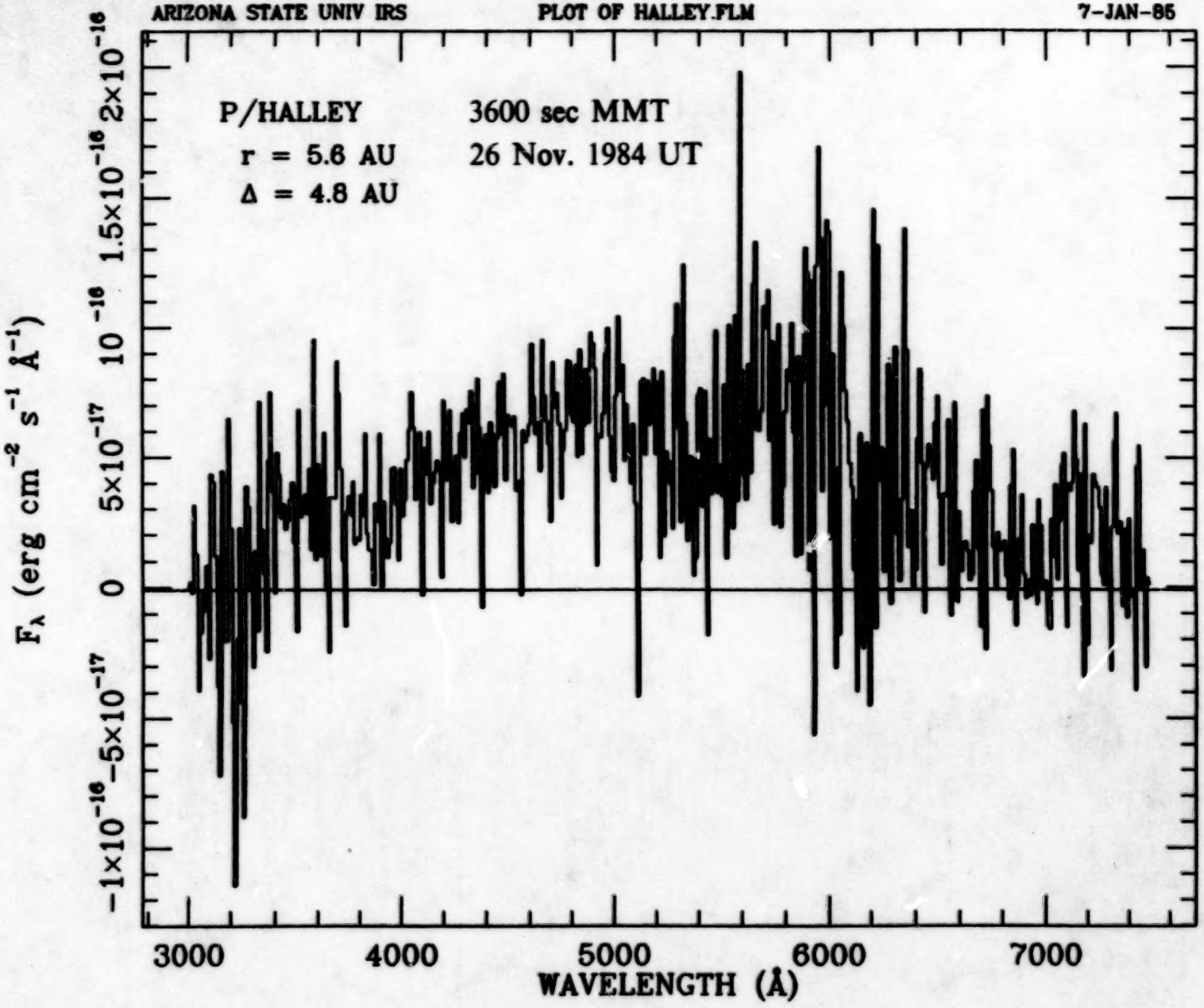

Figure 2. Spectrum of P/Halley, 26 Nov. 1984 UT, obtained with Multiple Mirror Telescope and an intensified reticon, integration 4000 seconds, spectral resolution = 10 Å, r = 5.60 AU, Δ = 4.76 AU, and V = 20.5 mag.

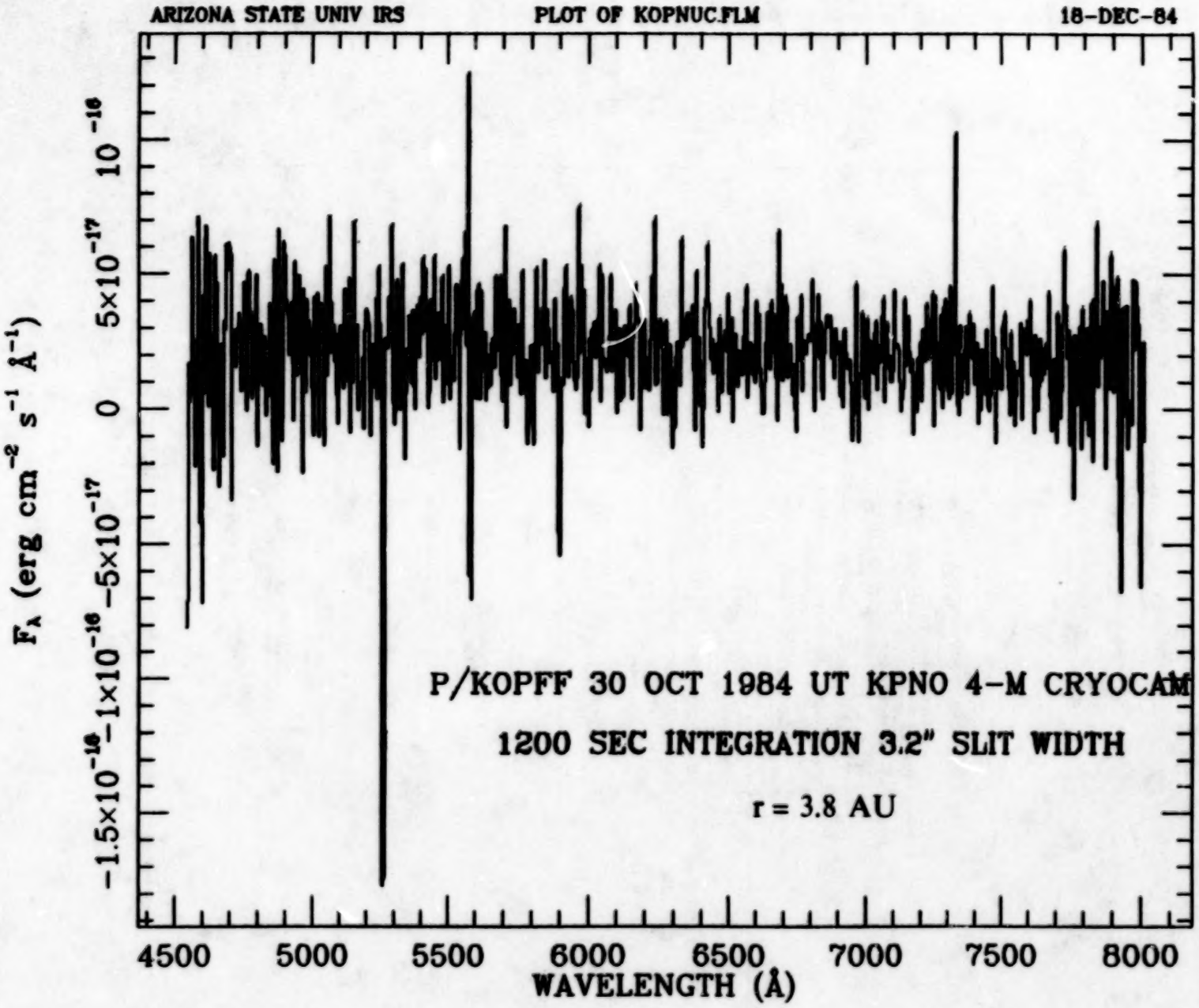

Figure 3. Spectrum of P/Kopff, 30 Oct. 1984 UT, obtained with KPNO 4-m telescope, integration 1200 seconds, r = 3.78 AU, and Δ = 2.83 AU.

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Planetary Sciences in October 1984. The MMT observing program is the work of S. Wyckoff, P. Wehinger, M. Belton, and M. Wagner and D. Schleicher (Arizona State). Additional observations are planned with both telescopes in the forthcoming months. M. Festou (Institut d'Astrophysique, Paris) and his coworkers are planning P/Halley observations with the Canada-France-Hawaii Telescope in late January 1985.

The KPNO 4 m telescope employs a grism in front of a cryogenically cooled Texas Instruments 800 x 800 pixel CCD at the Cassegrain focus. The spectral range covers 4550-8000 Å at a spectral resolution of 15 Å. The cryogenic camera can also be used for direct imaging when the grism is removed. Broad-band Bessel R (6000-7000 Å) CCD images of P/Halley were also obtained with this same system in February, September, and October 1984. In the spectroscopic mode, two-dimensional spectra are formatted on the central part of the chip, where the slit is 300 pixels (4.5 arc min) by 800 pixels (3450 Å). Thus far, all of the P/Halley spectra have been obtained using blind offsets from secondary astrometric standard stars selected to be 10-20 arc sec from the comet's predicted track based on Yeomans' ephemeris. In planning spectroscopic observations of P/Halley, observers are referred to the predicted light curve (prepared by Belton, Melroy, and Weismann) which appeared in IHW Newsletter, No. 4, p. 29.

The MMT observations employ an intensified double-array Reticon and are also acquired by using blind offsets. The Reticon spectra cover a spectral range of 3000-7500 Å at 12 Å resolution.

We have reduced flux calibrated spectra from three nights' observations, on the following UT dates: 1984 Feb. 4 (V = 23.5), Oct 30 (V = 21.4), and Nov. 26 (V = 20.5). At the time of this writing (1984 Dec. 15), no emission features (i.e., lines or bands) have been positively detected in P/Halley. All spectra show a reflected solar continuum. An extended coma was detected in the two-dimensional (long slit) spectra of P/Halley obtained with the 4 m telescope and cryogenic camera in the 30 October 1984 data under good seeing conditions. The coma is at least 12 arc sec in length in the sunward direction (at 6 AU, this length corresponds to 60,000 km). On 26 November 1984 the continuum flux was $F_\lambda = 2 \times 10^{-17}$ erg/cm^2/sec/Å. Only the 26 November 1984 data show any difference in color from the reflected solar continuum suggesting some reddening (with approximately a 30 percent increase in reflectivity between 4600-8000 Å) relative to the Sun. For comparison with P/Halley, we have also obtained a spectrum of P/Kopff on 30 October 1984 (at r = 3.8 AU), also by blind offsets when Kopff was about one magnitude brighter than Halley (Figure 3). Comet Kopff has been selected as a possible target for the NASA Comet Rendezvous Mission to be launched in 1990/91.

Two additional reports of spectra of P/Halley have been received by the Center for Spectroscopy. R. Ellis (Durham University, U.K.) telexed that he obtained spectra on 23 and 29 December 1984. His observations were made with the Isaac Newton Telescope at the La Palma Observatory (Canary Islands) and with the Faint Object Spectrograph (FOS) which employs a CCD located at the prime focus using a slit spectrograph with a fast optical system. At the McDonald Observatory E. Barker (University of Texas) reports observations with the 2.7 m telescope on 21 and 22 December 1984. The 21 Dec. data were direct CCD images while the 22 Dec. data were low signal to noise spectra obtained with an Image Dissector Scanner (IDS). Both the La Palma and the McDonald observations show continuous spectra with no emission features.

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Further details on all of the above observations will be reported in forthcoming IHW Newsletters.

Center For Spectroscopy

For those who can access our VAX computer by telephone (300 or 1200 baud), we will keep up-to-date information on the development of the spectrum of P/Halley in an account named: CENTER, which can be accessed with the password: NETWORK. The VAX telephone number is 602-965-2425 and the computer is accessible 24 hours a day.

The Cometary Spectroscopy Group at Arizona State University presently consists of Susan Wyckoff (Professor), Peter Wehinger (Research Professor), R. Mark Wagner and David Schleicher (Post-doctoral Fellows), Barbara Boothman (Scientific Programmer/System Manager), and Shiro Konno (Graduate Student). Overseas members of the Center for Spectroscopy include Discipline Specialist Michel Festou (Institut d'Astrophysique, Paris), and Bruce Peterson (Mount Stromlo and Siding Spring Observatories, Canberra).

We continue to operate a telex in our offices. The telex number is: 140289, answerback code: HALLEY ASU UT. In case our number is not working or busy, a second telex machine elsewhere on the ASU campus is: 667391, answerback code: ARIZ ST U TMPE. We wish to encourage observers to report their observations to us as soon as possible, and we will respond with an update of the state of the spectrum of P/Halley.

A Fortran program for reading and writing magnetic tapes in FITS format is nearing completion and will be available to all observers in March 1985. This program should be used for writing data on magnetic tape to expedite the reading of data tapes at the Center for Spectroscopy. This interactive program provides a means of describing spectroscopic observations, the instrumentation used, the telescope and the observing site, etc. We request that observers send reduced data (F_λ vs. λ) on nine-track magnetic tapes at 800 or 1600 bits per inch (bpi). We will return your magnetic tapes.

Telephone numbers within the Center for Spectroscopy at Arizona State University are listed below.

IHW Spectroscopy Office	602-965-1986
S. Wyckoff	602-965-2223
P. Wehinger	602-965-4063
M. Wagner	602-965-7719
D. Schleicher	602-965-7719
B. Boothman	602-965-1986
VAX Phone Link (300/1200 baud)	602-965-2425

Addresses, telephone and telex numbers for overseas members of the Center for Spectroscopy include:

M. Festou
Institut d'Astrophysique
98 bis Blvd. Arago
F-75014 Paris, FRANCE
Phone: 33-1-320-1425, Extension 213
Telex: 270070 Answerback INAG F

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B. Peterson
Mount Stromlo and Siding Spring Observatory
Australian National University
P. O. Private Bag
Woden, ACT 2606, AUSTRALIA
Phone: 61-62-88-111
Telex: AA62270 Answerback CANOPUS

Solar-Type Analogs And Flux Standards For Spectroscopy And Spectrophotometry

As discussed in IHW Spectroscopy and Spectrophotometry Bulletin No. 1 and in IHW Newletter No. 5, p. 57, we suggest that observers obtain a reasonably high signal-to-noise ratio spectrum of a solar-type analog star. This spectrum should cover the same spectral region as the comet with the same spectrograph and the same wavelength range and spectral resolution. The solar analog spectrum need only be obtained once for a given instrument configuration. Observations of solar analogs are important in order to remove the reflected solar spectrum from the comet and thus obtain the composite cometary spectrum due to dust and gas. Properties of the dust can be deduced from the reflection spectrum while the gas will be detected as emission features excited by resonance fluorescence.

A list of primary solar analog stars is presented in Table I. These stars have been suggested as solar analogs by Hardorp (1982) and are the same stars selected by A'Hearn for the IHW Photometry and Polarimetry Net. A list of other solar comparison stars is given in Table II. The five stars in the old galactic cluster M67 were suggested by Spinrad (cf. IHW Newsletter No. 5, p.57) and may be more suitable for observers using large telescopes and digital detectors. Additional information and finding charts for these stars can be found in Eggen and Sandage (1964) and Johnson and Sandage (1955). In Table III, a list of possible G stars fainter than 10th magnitude is presented selected on the basis of color only from the photometry of Landolt (1973). Finding charts are included with the reference. These stars are within ±1 deg of the celestial equator and should be accessible to observers in both the northern and southern hemispheres. For additional secondary G standards along the path of Comet Halley, the observer is referred to IHW Newsletter No. 4, p. 24 (Table 3). These stars were selected for the Photometry Net and range from V = 5 - 9 magnitudes.

Flux standard stars are suggested from the compilations by K. Strom (IIDS standards) and by J. Barnes and D. Hayes (IRS standards). The IIDS standards range in brightness from V = 11 - 15 magnitudes while the IRS standards are V = 6 - 12 magnitudes. Additional copies of these manuals can be obtained from:

IHW Center for Spectroscopy
Arizona State University
Tempe, AZ 85287
USA

S. Wyckoff
P. Wehinger

REFERENCES

Hardorp, J., 1982, Astr. Ap., 105, 120.

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Eggen, O. J., and Sandage, A., 1964, Ap. J., 140, 130.

Johnson, H. L., and Sandage, A., 1955, Ap. J., 121, 616.

Landolt, A. U., 1973, A. J., 78, 959.

TABLE 1

Primary Solar Analogs

HD	OTHER	RA (1950)	DEC	V	B-V	SPECTRUM	NOTES
28099	HYADES - VB 64	04 23 47.7	+16 38 07	8.12	+0.66	G6V	
29461	HYADES - VB 106	04 36 07.6	+14 00 29	7.96	+0.66	G5V	
30246	HYADES - VB 142	04 43 38.9	+15 22 59	8.33	+0.67	G5V	
44594	HR (YBS) 2290	06 18 47.1	-48 42 50	6.60	+0.66	G2V	
105590	BD -11 3246	12 06 53.2	-11 34 36	6.56	+0.66	G2V	1
186427	16 CYG B	19 40 32.0	+50 24 03	6.20	+0.66	G5V	2
191854AB	BD +43 3513	20 08 33.7	+43 47 43	7.42	+0.66	G5V	3

NOTES:

1 - BRIGHTEST MEMBER OF A TRIPLE SYSTEM; 8.9 AND 9.1 MAG COMPANIONS AT (1.6 SEC E, 4 ARCSEC N) AND (0.5 SEC W, 23 ARCMIN S).

2 - FAINTER MEMBER OF A DOUBLE SYSTEM, 6.0 MAG COMPANION AT (3 SEC W, 28 ARCSEC N).

3 - UNRESOLVED DOUBLE STAR, SEMI-MAJOR AXIS ABOUT 0.45 ARCSEC.

TABLE 2

Other Solar Comparison Stars

HD	OTHER	RA (1950)	DEC	V	B-V
	M67 - STAR t	08 47 48	+12 00	14.05	+0.64
	M67 - STAR m			14.83	+0.69
	M67 - I-44			13.59	+0.67
	M67 - I-160			14.46	+0.67
	M67 - III-42			13.67	+0.65
	SAO 120107	13 44 27.5	+06 16 37	9.26	
120528	SAO 28894	13 46 46.7	+53 30 36	8.55	+0.66
144873	SAO 65083	16 04 47.3	+34 14 01	8.84	
	BD +15 3364	18 05 04.1	+15 56 27	8.64	+0.65
191854	SAO 49262	20 08 33.7	+43 47 43	7.43	+0.69

NOTE: RA AND DEC GIVEN FOR THE M67 STARS REFERS TO THE CENTER OF THE CLUSTER.

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TABLE 3

Possible G Stars Fainter Than
10th Magnitude

LANDOLT #	RA (1975)	DEC	V	B-V	COMMENTS
92-433	00 55 37	+00 52 36	11.65	+0.66	
93-180	01 51 10	+00 24 55	11.24	+0.65	
93-395	01 52 27	+00 50 19	11.64	+0.67	
94-90	02 56 59	-00 07 32	11.89	+0.66	
95-338	03 54 14	+00 29 46	12.33	+0.65	
97-249	05 55 51	+00 01 04	11.74	+0.65	
98-313	06 51 29	-00 34 07	11.07	+0.66	
100-61	08 52 43	-00 49 00	12.72	+0.65	
103-487	11 53 54	-00 15 19	11.84	+0.66	
104-483	12 43 00	-00 19 23	12.08	+0.67	
105-135	13 36 19	-00 56 31	11.28	+0.65	1 OBS
105-350	13 37 14	-00 41 37	10.75	+0.67	1 OBS
105-513	13 34 41	-00 13 47	12.14	+0.67	
107-871	15 38 00	+00 13 42	12.48	+0.65	
108-1372	16 34 33	+00 00 06	11.69	+0.67	1 OBS
114-654	22 40 09	+01 02 20	11.83	+0.66	
115-366	23 43 01	+00 52 50	12.11	+0.64	
115-546	23 39 50	+01 22 49	12.12	+0.65	

THE AMATEUR OBSERVATION NETWORK

As of December 21, 1984, 288 amateur astronomers have formally registered as IHW participants by returning the Observer Index form distributed in the Halley Watch Amateur Manual. Thirty-six states in the U.S. have 158 registrants and 34 other nations are represented by 130 observers. Eight Amateur Observer's Bulletins have been issued, typically containing six pages every two months. Readers are now submitting contributions which help flesh out the Bulletin. When time-critical material is in the Bulletin, a special, early mailing is made to registered observers.

S. J. Edberg

ORBIT UPDATES

Halley Orbit

The following osculating orbital elements are suitable inputs for the two body ephemeris generation program.
The times are in E.T. and the angles are referred to the ecliptic plane and the equinox of 1950.0.
The current correction for ET - UTC = 54.2 secs.

Observational arc: 1835/8/21 - 1984/11/26
Number of observations in fit: 789
RMS of residuals: 2.94 arc seconds
Weighted RMS of residuals: 1.95 arc seconds
Date of fit: 12/10/84
From Yeomans' Orbit #18: Nongrav. parameters A1=0.1399
A2=0.0155

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EPOCH 1985 Jan. 15.0 = 2446080.5
T 1986 Feb. 9.43400 = 2446470.93400
Q 0.5873697 AU
E 0.9673127
W 111.82147
NODE 58.13389
I 162.24572

EPOCH 1986 Feb. 19.0 = 2446480.5
T 1986 Feb. 9.44148 = 2446470.94148
Q 0.5870993 AU
E 0.9672727
W 111.84661
NODE 58.14398
I 162.23933

G-Z Orbit

The following osculating orbital elements are suitable inputs for the two body ephemeris generation program.
The times are in E.T. and the angles are referred to the ecliptic plane and the equinox of 1950.0.
The current correction for ET - UTC = 54.2 Secs.

Observation arc: 1972/3/11 - 1984/7/21
Number of observations in fit: 84
Standard deviation of residuals: 1.17 arc seconds
Date of fit: 9/25/84

From Yeomans' orbit #10
Nongravitational parameters: A1 = -0.0543 D-08 AU/ (EPH. DAY)**2
A2 = -0.0465 D-08

EPOCH 1985 Sept. 12.0 = 2446320.5
T 1985 Sept. 5.24907 = 2446313.74907
Q 1.0282614 AU
E 0.7075300
W 172.48887
NODE 194.70595
I 31.87829

EPOCH 1985 Jan. 15.0 = 2446080.5
T 1985 Sept. 5.25778 = 2446313.75778
Q 1.0281043 AU
E 0.7075151
W 172.49282
NODE 194.71577
I 31.87924

D. K. Yeomans

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UPDATED PREDICTIONS OF OCCULTATIONS OF STARS BY COMET HALLEY

E. Bowell and L. H. Wasserman
Lowell Observatory
P. O. Box 1269
Flagstaff, AZ 86002

We present here updated predictions of occultations of stars by P/Halley during the interval 1984 December 14 through 1987 July 4. The ephemeris of P/Halley results from "orbit No. 17" by D. K. Yeomans, which includes accurate observations through 1984 November 26. Our new results are very little different from those described by us in IHW Newsletter No. 5, pp. 72-87, to which the reader is referred for a more detailed description. The ephemeris resulting from "orbit No. 17" differs by less than 2 arcsec in declination from the one previously used by us; consequently, most of the predicted appulses and, where applicable, ground tracks, are similar.

The table lists 21 events that should lead to central occultations of stars by P/Halley somewhere on Earth, and the six figures show the predicted ground tracks. For a more extensive listing, including more distant appulses, refer to IHW Newsletter No. 5.

We will continue to refine predictions of occultations of stars and radio sources by P/Halley as new and better orbits become available, although we anticipate only minor changes from the lirts already published. In addition, we expect soon to make occultation predictions for P/Giacobini-Zinner. Those interested in receiving updated predictions, together with topocentric observing circumstances, are invited to get in touch with us or with D. K. Yeomans (Jet Propulsion Laboratory).

APPULSES BY P/HALLEY

START DATE: 1984 DEC 14.000

HALLEY TRACK CATALOG SEARCH - EVENTS WITH GROUND TRACKS

STAR NUMBER	MINIMUM SEPARATION (ARCSEC)	DATE (U.T.)	TRANSV VEL (KM/SEC)	STAR TO COMET DIRECTION	RA (1950.0) (EPOCH OF EVENT)	DEC	MAG	SOLAR ELONG
3716	0.4	1985 MAR 17.91844	7.4	S	4 51 39.410	14 16 1.74	13.00	76.6
8462	0.8	1985 OCT 6.18811	8.2	N	6 9 5.252	20 12 5.28	13.50	100.2
8172	3.1	1985 OCT 15.89297	14.6	S	6 0 8.441	20 40 34.79	13.90	111.9
+21 0616	5.8	1985 NOV 12.96733	42.8	N	4 14 38.661	22 8 16.89	9.20	164.3
+20 0531	1.4	1985 NOV 19.59534	50.1	N	3 13 8.527	20 51 12.23	8.20	174.1
+19 0424	7.9	1985 NOV 22.12311	52.0	S	2 45 30.189	19 48 9.47	8.30	165.3
1511	4.9	1985 NOV 25.71003	53.2	N	2 4 21.497	17 42 4.39	11.10	151.8
+12 0114	10.4	1985 DEC 2.07872	50.2	N	0 54 11.129	12 45 31.69	10.00	127.8
+09 0046	10.8	1985 DEC 5.09043	47.2	S	0 25 24.438	10 18 17.32	10.60	117.3
+06 5207	5.3	1985 DEC 9.82571	41.5	N	23 47 35.098	6 46 9.04	9.10	102.5
-03 5403	2.7	1986 JAN 2.79456	22.2	S	22 10 43.515	-2 58 53.45	9.00	52.4
-20 5852	2.3	1986 MAR 9.86232	21.9	N	20 9 53.497	-19 54 53.84	9.00	48.2
-3512981	1.5	1986 MAR 29.31267	38.9	N	18 48 54.287	-35 12 45.32	8.20	87.7
-4311763	6.0	1986 APR 4.61251	50.2	S	17 26 51.916	-43 42 57.56	7.50	109.1
-45 8209	5.7	1986 APR 6.29913	52.8	N	16 53 1.990	-45 39 55.19	9.60	115.9
-45 8176	12.0	1986 APR 6.49601	53.1	S	16 48 42.163	-45 51 15.46	7.80	116.7
-45 6861	6.6	1986 APR 12.13618	56.9	S	14 25 48.436	-46 5 52.16	9.00	139.6
-44 6616	10.7	1986 APR 13.24033	56.3	N	13 58 48.547	-44 47 44.93	7.50	143.2
-42 6280	2.7	1986 APR 14.72051	54.9	S	13 26 2.498	-42 31 48.00	9.60	146.8
-34 8087	6.9	1986 APR 18.82073	48.3	N	12 17 58.398	-34 57 18.18	5.30	148.9
-25 8682	5.1	1986 APR 24.49603	38.1	N	11 25 8.642	-25 35 6.97	6.80	140.3

END DATE: 1987 JUL 4.000

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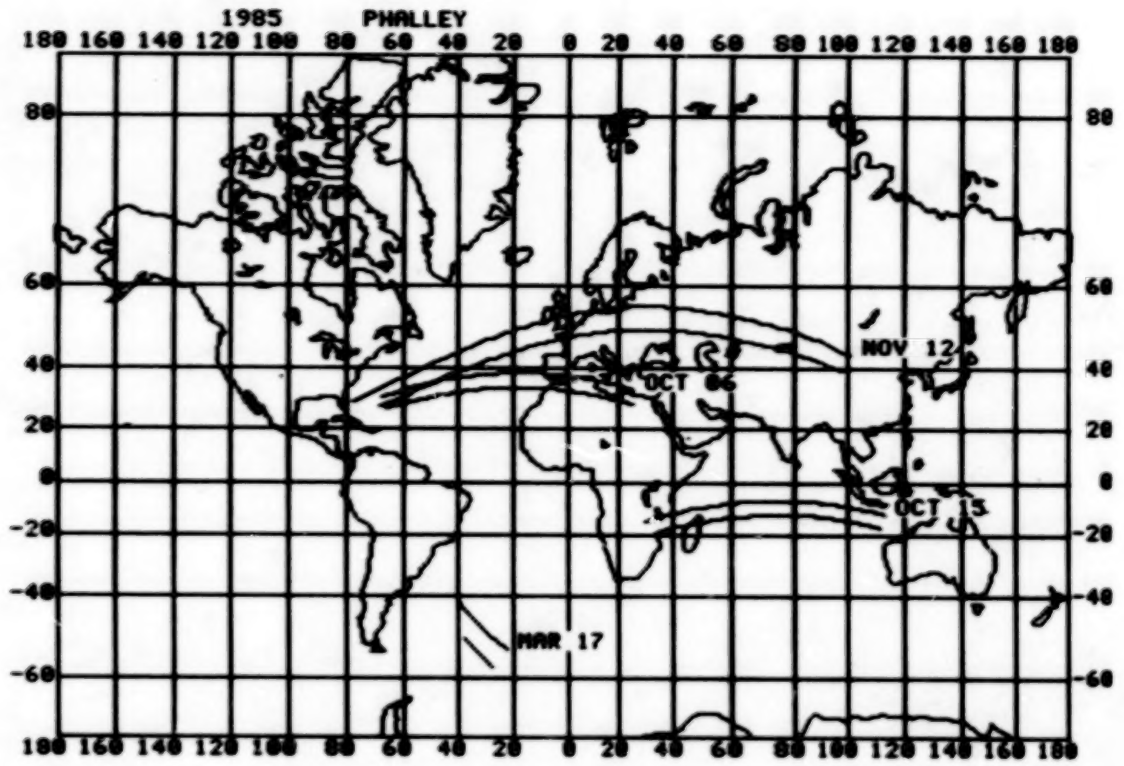

Figure 1.

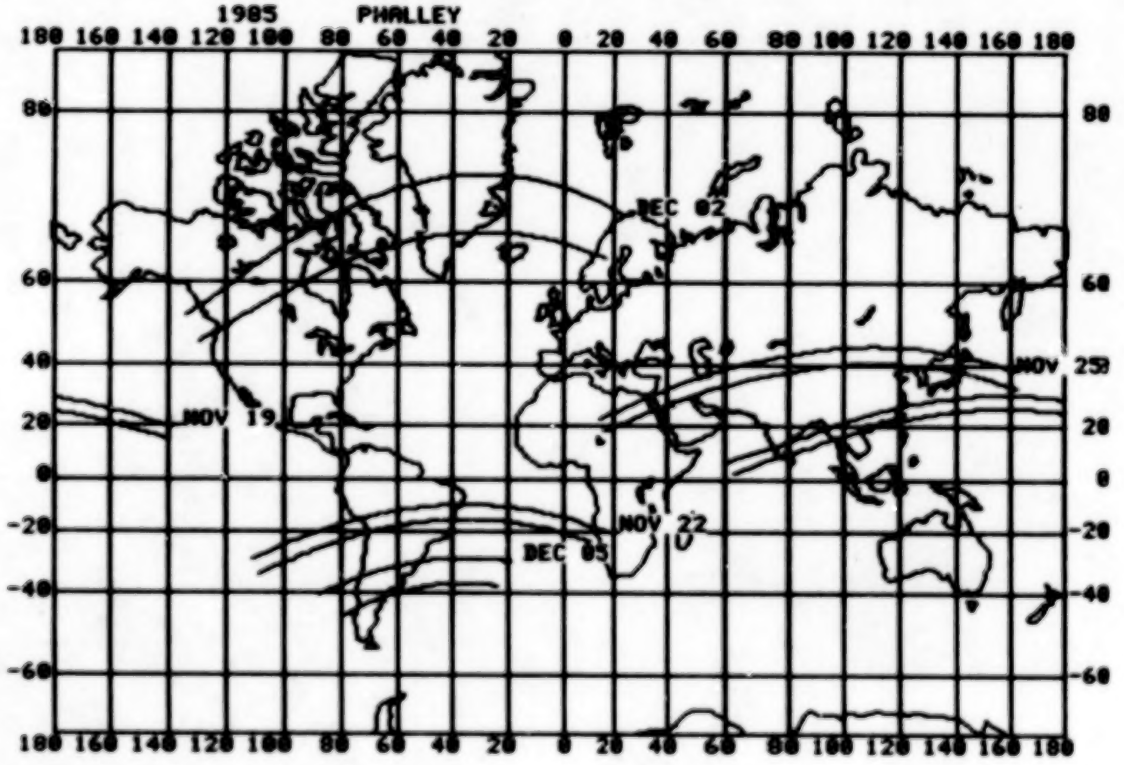

Figure 2.

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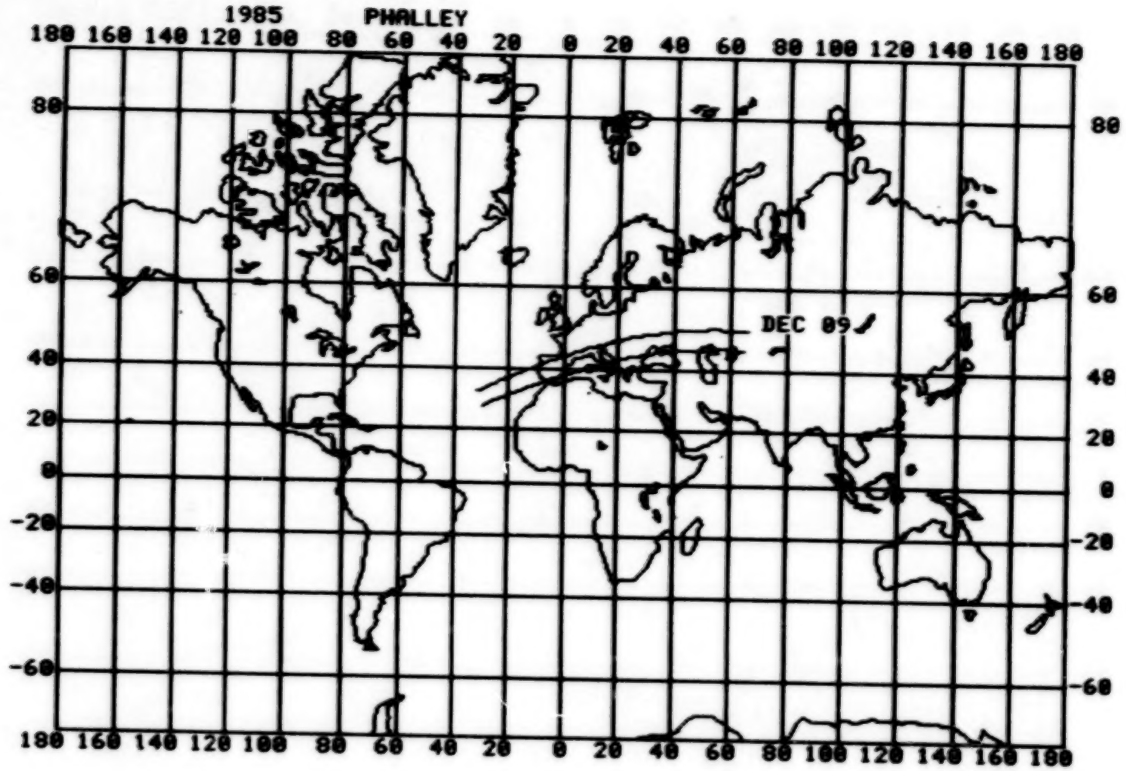

Figure 3.

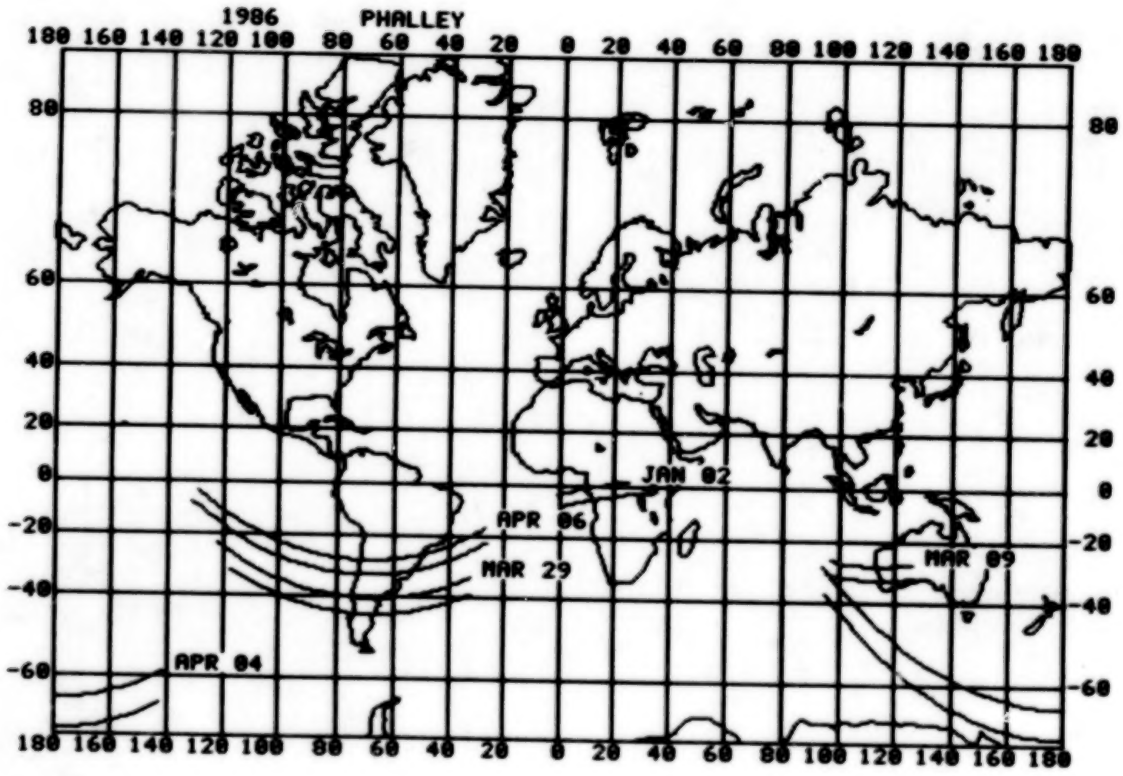

Figure 4.

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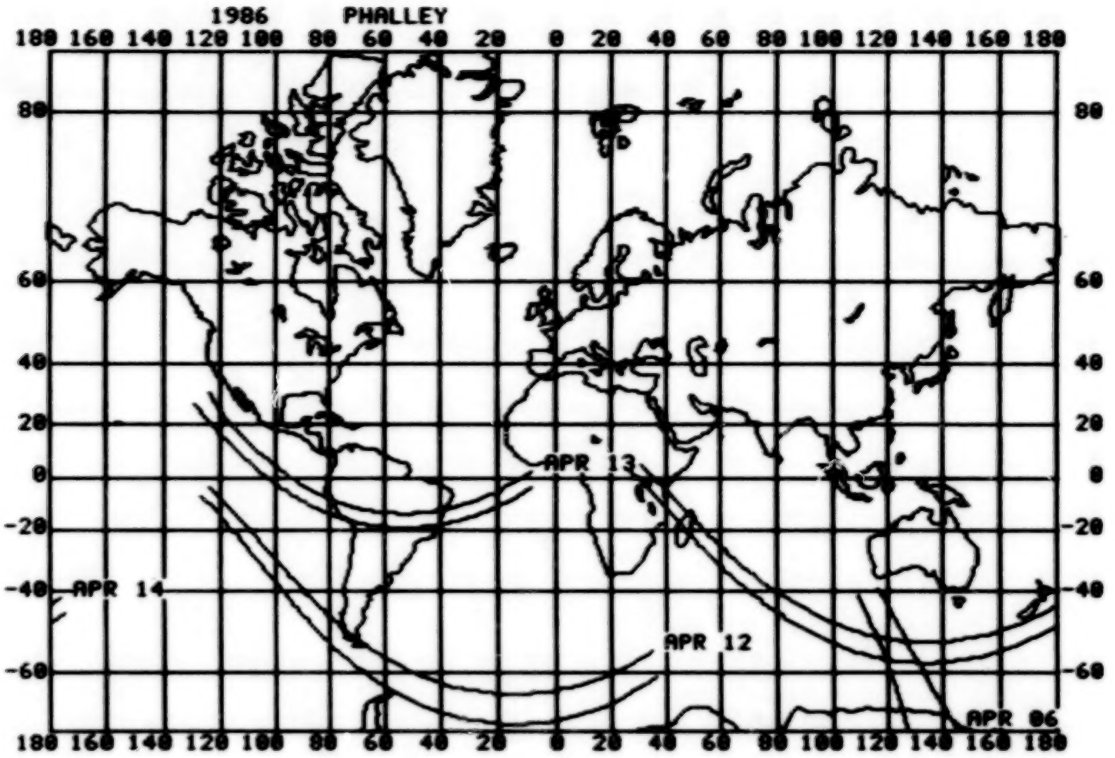

Figure 5.

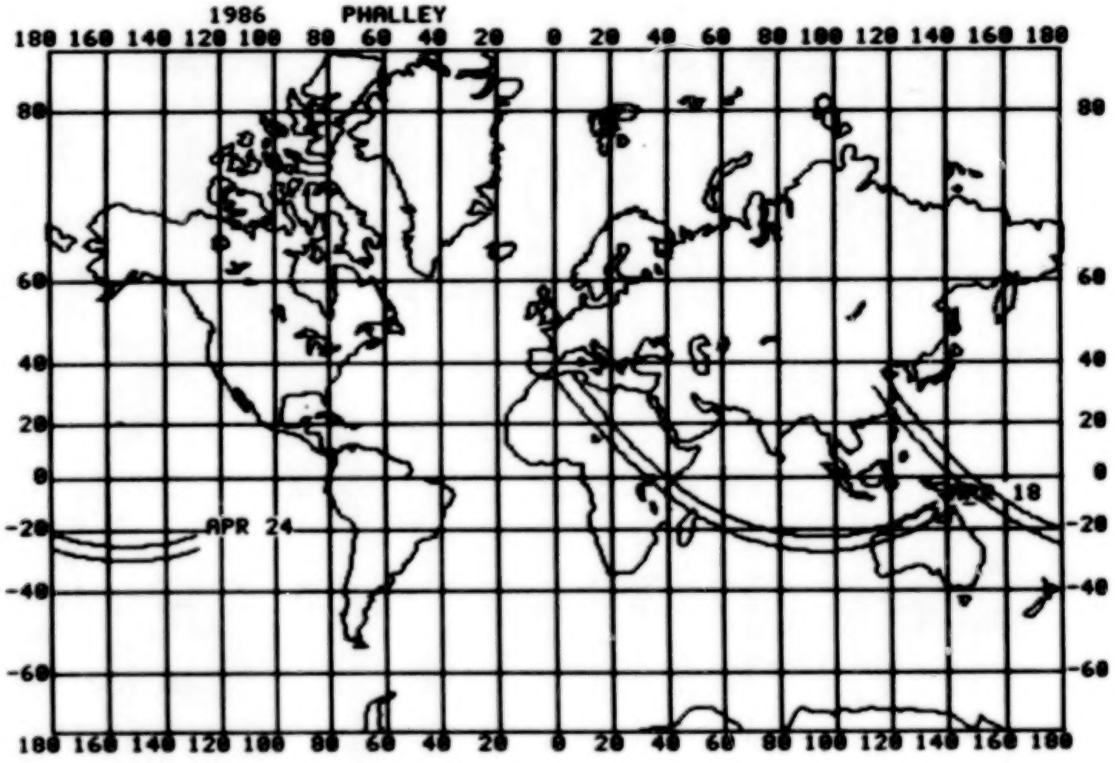

Figure 6.

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LAUNCHING ANNOUNCEMENT

The Institute of Space and Astronautical Science (ISAS) launched successfully the first Japanese interplanetary probe MS-T5 into heliocentric orbit at 04^h 26^m 00^s (JST) on 8th January 1985 from the Kagoshima Space Center, at Uchinoura, Kagoshima Prefecture. The first objective of this spacecraft is to confirm the capabilities of new launcher, M-3SII-1, and the system of interplanetary exploration including both spacecraft and new deep space station with 64 meter dish at Usuda, Nagano Prefecture. The second one is to measure solar wind by means of ion probe, plasma wave probe, and magnetometer after many technical performance tests finish. The solar wind observation contributes also to the exploration of Comet P/Halley during March 1986. The midcourse correction was carried out on 11th January.

The closest encounter to the Comet P/Halley is as follows:

Date and time 04^h09^m (UT), Mar. 11, 1986
Distance 7.02 million km

The spacecraft transmits 2293.15 MHz with 0.07/5 watts with coherent/non-coherent modes for ranging/telemetry.

The spacecraft is cylindrical type of 1.4 meter diameter and 0.7 meter height and weighs 138.1 kg. All instruments are functioning satisfactorily. Scientific experiments will start middle of February. First onboard check of these experiments will be done on 24th January.

The spacecraft is named "Sakigake"; English meaning is Pioneer.

K. Hira[illegible], ISAS
Chairman, National Committee for COSPAR

A.S.P. MEETING ANNOUNCEMENT

Comets and Asteroids to be Featured at Summer Meeting

A symposium on "New Directions in Asteroid and Comet Research" will highlight the 97th Annual Meeting of the Astronomical Society of the Pacific June 22 through 27. To be held at Northern Arizona University in Flagstaff, the meeting will also feature a series of nontechnical lectures on recent developments in astronomy, a workshop for teaching astronomy in high school and college, a session on the history of astronomy, and special tours of Meteor Crater, the Lowell Observatory, and the Grand Canyon.

A number of astronomers are expected to have first results at the meeting from observations of Comet Halley planned for Spring 1985.

For more information and a registration form, write to:

Summer Meeting
A.S.P.
1290 24th Ave.
San Francisco, CA 94122

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